31. Studies on the Anoplura and Mallophaga, being a Report upon a Collection from the Mammals and Birds in the Society's Gardens.—Part II.* By Bruce F. Cummings, British Museum (Natural History)†.

[Received August 4, 1916: Read November 21, 1916.]

(Text-figures 1–36.)

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Snodgrass (1), in 1899, pointed out certain broad features of divergence in the internal anatomy among the larger divisions of the Mallophaga, such as the Amblycera, the Ischnocera, and the family Trichodectidæ. Recently, Harrison (2) has claimed the existence of a large accessory sac of unknown function in connexion with the male reproductive organs as the chief and most reliable character for separating the family Boöpidæ from all other Mallophaga. In 1910 Mjöberg's sketches of the male reproductive system in several Mallophaga (6) offered the systematist an inducement to compare such organs as the vesicula seminalis, the ductus ejaculatorius, and the spermatheca, in order to discover the extent of their divergences in different species and genera. In the following paper some evidence on this subject is brought forward. So far from there being a monotonous uniformity in these internal organs, the differences are such as no student of these little parasites can afford to neglect. The ultimate systematic value of such characters can only be estimated after many more dissections; but whether it be great or small, the considerable difference in the form of the *vesicula* between the two Owl Philopteri—*Philopterus ceblebrachys* and *P. cursor*,—to take an example, is one which cannot be satisfactorily ignored and which conveniently falls within the province of the systematic writer to record.

Methods.

All chitinous parts were studied after hot caustic potash had cleared away the soft parts. For an examination of the soft

* Part I. appeared in the P. Z. S. 1916, p. 253.

† Published by permission of the Trustees and communicated by the Secretary. [Owing to the illness of Mr. Cummings, the final proofs of this paper have been corrected, and the magnifications of the figures worked out, by the Rev. James Waterston, B.D., B.Sc., of the Imperial Bureau of Entomology.—Editor.]

parts, fresh material was not available; but it was found that good results may be obtained with well-preserved spirit material if the specimens be plunged for a few minutes in caustic potash, to destroy the connective tissue, and then soaked for twelve hours in glacial acetic acid, transferred to absolute alcohol, dissected in oil of cloves, and mounted in Canada balsam.

For sectioning, the specimens had been fixed in Carnoy's solution (Formula No. II.), which proved, however, to be not very satisfactory. For imbedding, Awati's methods, detailed in the P. Z. S. for 1914 (p. 686), were followed, the sections being stained in the ordinary way with Ehrlich's Hæmatoxylin, Eosin, or Orange G. I am much indebted to Mr. C. A. Gunns for assistance in section-cutting.

[In none of the figures which follow of the male reproductive system and copulatory apparatus are the muscles shown, and in some the exact position of the entry of the *vas deferens* into the *ductus* is not given because, as a rule, in most of the dissections this could only be made out with the greatest difficulty on account of the delicacy of the *vas deferens*.]

Family Philopteridæ.

The Owl Philopteri.

Piaget (**3**) grouped the Owl Philopteri together, under the general name "Strigicolæ." For convenience, this plan may still be followed. But these Owl parasites cannot very easily be separated off as generically distinct from the Philopteri of Birds of Prey, with which they show certain affinities. Within themselves they fall into three distinct types, as pointed out by Prof. V. L. Kellogg (**4**), represented by the following three species:—*P. rostratus* Nitzsch, *P. ceblebrachys* Nitzsch, and *P. cursor* Nitzsch.

The following four species were included in the collection:—

Philopterus rostratus Nitzsch (**5**, p. 76).

4 ♀♀, from the Barn-Owl, *Flammea flammea* (Linn.)*.

Dissections were made from male material kindly handed over to me by Mr. Waterston.

Philopterus cursor Nitzsch (**5**, p. 75).

Several specimens of both sexes, from *Bubo maculosus* (Vieill.) (S. Africa) and *B. ascalaphus* (Savign.) (Egypt). *P. cursor* has been further recorded from *B. capensis* Smith, *B. virginianus* (Gmel.), *Asio accipitrinus*, *A. wilsonianus* (Less.), and *A. galapagensis* (Gould).

* [The parentheses around the names of authors placed after scientific names in this paper are used in accordance with Article 23 of the International Rules of Nomenclature (Proc. 7th Int. Cong. Boston, 1907, p. 44 (1912)).—Editor.]

PHILOPTERUS CEBLEBRACHYS Nitzsch (5, p. 77).

Many examples, male and female, from *Nyctea nyctea* (Linn.) and *Strix aluco* Linn. This very distinct round-headed species has been reported also from *Nyctala tengmalmi* (Gmel.), *Surnia ulula* (Linn.), and others.

PHILOPTERUS ATHENE Mjöberg (6, p. 115).

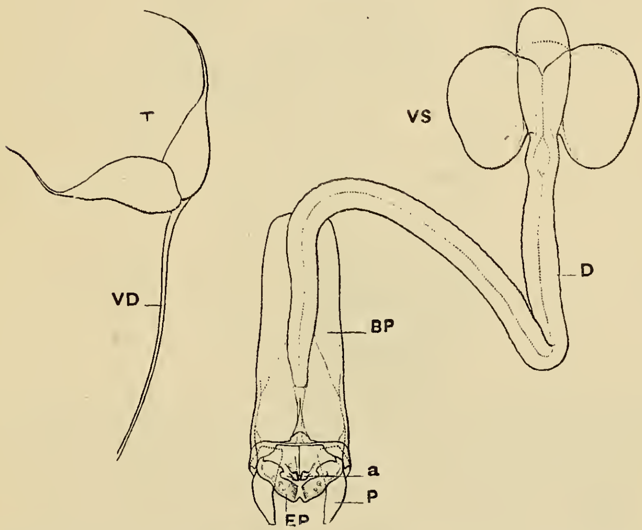
Many examples of both sexes, from *Athene noctua* (Scop.) (Cairo). Mjöberg's specimens came from *Athene glaux* (Savign.). The British Museum possesses specimens presented by the Hon. N. C. Rothschild, and taken on an unidentified Owl in Abyssinia.

Male Reproductive System of Owl Philopteri.

Of the three species dissected—*P. cursor*, *P. ceblebrachys*, and *P. athene*, the vesiculæ of *P. cursor* and *P. athene* are somewhat alike, while that of *P. ceblebrachys* differs strongly from both :—

Philopterus cursor (text-fig. 1).—There are the usual two

Text-figure 1.



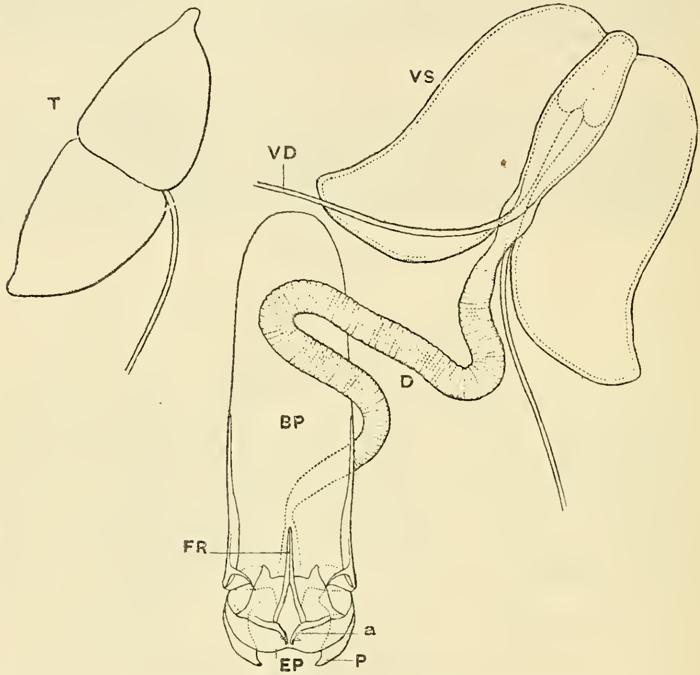
Philopterus cursor. Male reproductive system and copulatory apparatus. × 100.

T. testis. *VD.* vas deferens. *VS.* vesicula seminalis. *D.* ductus. *BP.* basal plate. *a.* transverse piece. *P.* paramere. *EP.* endomeral plate.

pairs of testes, large pear-shaped organs, the round ends approximated and united by a commissure. The *vesicula seminalis* in a *Philopterus* of the *cursor* type, perhaps *P. nudipes* P. from *Asio* sp., is a large oval organ of much the same form as that figured by Snodgrass (**1**, pl. xiii. figs. 7, 8, & 9) for *Colpocephalum flavescens* and *Eurymetopus taurus*. In *P. cursor*, on account of the swelling out and rounding of the two separate sacs of which the *vesicula* is composed, it approximates to the form of the *vesicula* in *P. ceblebrachys* (text-fig. 2). Note the relatively small size.

Philopterus ceblebrachys (text-fig. 2).—In outline the *vesicula*

Text-figure 2.



Philopterus ceblebrachys. Male reproductive system and copulatory apparatus. × 100.

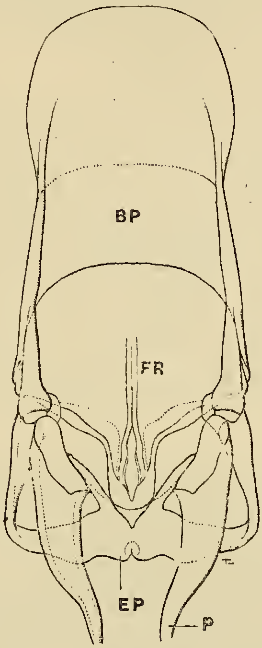
T. testis. *VS.* Vesicula seminalis. *VD.* vas deferens. *D.* ductus. *BP.* basal plate. *FR.* forked rod. *a.* transverse piece. *P.* paramere. *EP.* endomeral plate.

resembles Minerva's helmet. In between the rounded posterior "horns," which sweep backwards and outwards, the *ductus* enters and swells out at once into an oval form.

Male Copulatory Apparatus of the Owl Philopteri.

Philopterus rostratus (text-fig. 3).—Distinguished by the unusually long parameres in proportion to the basal plate, a feature which separates the species from all other Owl Philopteri so far examined. *Basal plate*: Rather short, broad; lateral margins strongly chitinised along posterior half. The hind margin juts out medially into a prominence beneath the endomeral plate. *Parameres*: Elongate rounded rods, graduated to a slender distal end, and slightly curving inwards towards one another. *Endomeral plate*: Quadrilateral, as broad as the basal plate to which it is attached, and about half the length of the parameres. The endomeral plate has a marginal band which

Text-figure 3.



Philopterus rostratus. Male copulatory apparatus. × 200.

BP. basal plate. *FR*. forked rod. *EP*. endomeral plate. *P*. paramere.

along the lower side deepens considerably in the middle part, where it bends upwards between the parameres and sends backwards across the plate two diverging splints. Each of these runs halfway along the oblique base-line of the articular surface of the paramere. The forked rod (see text-fig. 1) is homologous with similar parts in *P. cursor*, *P. ceblebrachys*, and *P. athene* (see text-figs. 1–3).

Philopterus cursor (text-fig. 1).—*Basal plate*: Compared with parameres this is very long indeed, fairly broad, the lateral margins divergent from in front posteriorly. *Parameres*: Short, inwardly curved, flattened, with acute tips. *Endomeral plate*: This runs out between the parameres into a broad rounded apex. There is a median longitudinal groove and a transverse groove cutting the former at halfway, dividing the plate into four sections of the shape seen in the figure. Under a high power there are visible on these areas eight white spots, probably representing the alveoli of minute sensory hairs. There are three of these in each posterior area and one in each anterior area. The forked rod is thinly chitinized, but recognizable. The two small nodular swellings at "*a*" are ridged and densely chitinised, and may be homologous with the parts similarly lettered in *P. ceblebrachys* and in *P. asturinus* with the penis.

Philopterus ceblebrachys (text-fig. 2).—*Basal plate*: About four times as long as the parameres. The posterior half is broader than the anterior half, and possesses strongly chitinised, parallel, lateral margins. *Parameres*: Quite short, stout, slightly incurved. *Endomeral plate*: Broad behind, nearly as long as parameres. Posterior lateral angles rounded. A narrow band runs along posterior margin. Lateral margins straight, convergent anteriorly. Anterior margin short, straight, each anterior lateral angle produced into an outwardly curved process. Forked rod well developed, the handle of the fork incompletely fused, indicating its originally double nature. The transverse piece is homologous with the part similarly shaped in *P. athene*.

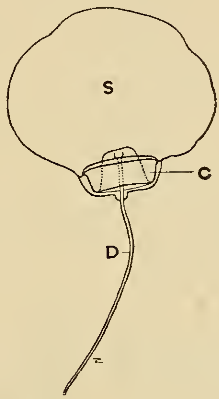
Philopterus athene.—This resembles the apparatus of *P. ceblebrachys*. In length of the head this species recalls *P. rostratus*; in the form of the *vesicula seminalis* it approximates to *P. cursor*, but the vesicula of *P. rostratus* I have not yet been able to examine. *Basal plate* and *Parameres*: As in *P. ceblebrachys*. *Endomeral plate*: As in *P. ceblebrachys*, except for the concave posterior margin. "*Forked rod*": Represented by two rods converging posteriorly. *The transverse piece*: This is obviously homologous with the part so named in *P. ceblebrachys*, but each half is concave and not straight.

The Mouth-parts of Philopterus ceblebrachys.—*Lyriform organ*: Anterior cornua short and broad; posterior cornua absent. *Labium*: A labial sclerite is present, as in *Trichodectes gastrodes* Cummings (7, p. 99) and in *Goniodes falcicornis* Nitzsch (Part I. p. 287); its posterior cornu on each side curves outwards and stops at the base of the "paraglossa"; the transverse bar is short and situated far forward, near the front margin of the labium; anterior cornua absent.

The Receptaculum seminis.

Philopterus ceblebrachys (text-fig. 4).—Piaget (**3**, p. 30), in describing this species, says :—" A la face ventrale deux bandes longitudinales sur les côtés de la valvule qui est peu visible, et deux taches arquées dos à dos, avec un petit cercle de chitine en avant." As Mjöberg points out (**6**, p. 256), this " petit cercle de chitine," figured by Piaget in several species, is not a superficial character of the exoskeleton, but a part of the receptaculum seminis strongly chitinised and showing through the integument. The receptaculum consists of a small more or less circular sac of soft delicate tissue carried by a dark-brown thickly-chitinised *calyx* at the end of a fine duct leading into the genital chamber.

Text-figure 4.



Philopterus ceblebrachys. Receptaculum seminis, × 100.
S. sac. *C.* calyx. *D.* duct.

Mjöberg calls this a " kreisrunde Chitinscheibe," and figures it in *Nirmus lineolatus* just as if it, indeed, were a flat circular disc on one side of the base of the sac. In *P. ceblebrachys* the calyx is a saucer-shaped piece of chitin with a rim. The duct enters through the centre of its membranous bottom and debouches at the tip of a large chitinous cone, which overtops the side of the calyx and at its base is continuous with the calyx, so that in optical section it looks as if the bottom has been pushed clean through the centre.

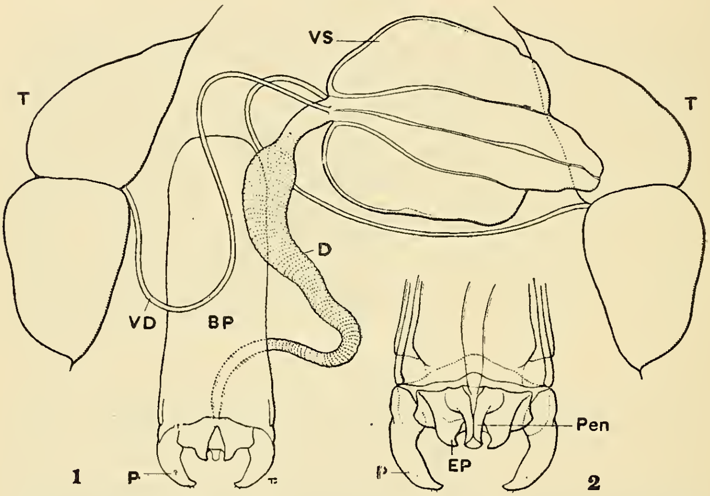
In an Owl *Philopterus* of the *cursor* type, from *Asio otus*, the *calyx* differs from that in the preceding in several respects. The outer surface is closely striated in a more or less longitudinal direction, the constriction below the rim is deeper, and the " cone " is parallel-sided at its upper end and has a truncate broad top.

The text-figure should be compared with those of *Ibidœcus* and *Neophilopterus* (p. 672). Relatively, the *calyx* in the *Philopterus* species is much wider across and shallower, and the chitin is of an entirely different consistency, being dark brown, rather thin, but very firm.

The Philopteri of Birds of Prey.

Future research may bring the Philopteri of the Owls and the Birds of Prey into closer relationship—a result which, according to modern views on the classification of birds, would lend no support to the theory that the phylogeny of total obligate

Text-figure 5.



Philopterus asturinus. Male reproductive system and copulatory apparatus. 1. ventral, × 100; 2. dorsal, × 150.

T. testis. *VS.* vesicula seminalis. *VD.* vas deferens. *BP.* basal plate. *D.* ductus. *P.* paramere. *EP.* endomeral plate. *Pen.* penis.

parasites like Anoplura and Mallophaga will assist in the unravelling of the phylogeny of their hosts, as ornithologists present a solid front against the old position of the Owls among the Birds of Prey. Between the two groups there is a strong likeness, for example, in the male copulatory apparatus.

Philopterus platystomus Nitzsch (**5**, p. 69).

Females and larvæ from *Buteo erythronotus* (King) (Argentine).

PHILOPTERUS PICTUS Giebel (**5**, p. 68).

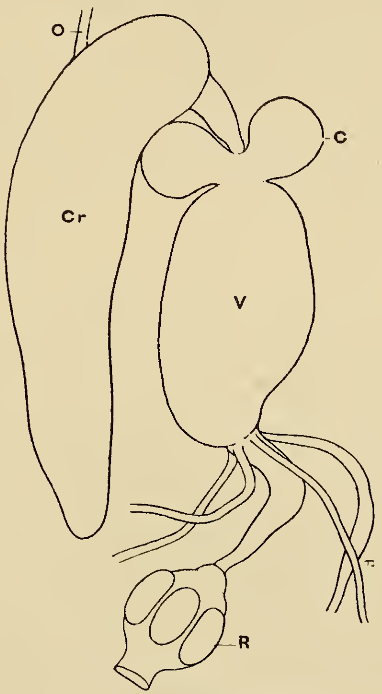
1 ♂ & 1 ♀ from *Aquila chrysaëtos* (Linn.).

PHILOPTERUS ASTURINUS Mjöberg (**6**, p. 112).

Males and females rather plentifully from the Goshawk (*Astur palumbarius* (Linn.)).

This species comes close to Denny's type-specimens of *P. nisi* from *Accipiter nisus* (Linn.), which Piaget—I do not know with how much reason—synonymises with *P. gonorhynchus*.

Text-figure 6.



Philopterus asturinus. Alimentary canal. × 70.

O. œsophagus. *C.* cæcum. *Cr.* crop. *V.* ventriculus. *R.* rectal glands.

Male Reproductive System and Copulatory Apparatus (text-fig. 5).—Testes and vas deferens as usual. The *vesicula seminalis* is a little elongate, of the shape given in the figure. *Basal plate*: Short and broad, lateral margins well chitinised along whole length, slightly convergent in front. *Parameres*: Short, stout, curved, very much as in the Owl Philopteri (except *P. rostratus*). *Mesosome*: Ventrally, running out from the posterior margin of basal plate, is a short stout penis-like tube formed of two distinct longitudinal halves. Each half is densely chitinised and dark brown in colour, and at the base spreads out towards the base of the paramere. This tube is perhaps homologous with the transverse piece of *P. ceblebrachys* and other Owl Philopteri (see text-figs. 1 & 2). The *endomeral plate* corresponding with the same piece in the Owl Philopteri overlies the rest of the mesosome and bridges across from the base of one paramere to the other. The *ductus ejaculatorius* runs in *under* the bridge. The endomeral plate may either consist of two pieces superimposed upon one another—viz., the deeply bifid band marked in the text-figure and the plate above this stretching across from paramere to paramere; or these parts may only be sculpturing or local thickenings in the same plate of chitin.

Alimentary Canal (text-fig. 6).—This belongs to the common Ischnoceran type figured by Snodgrass (**1**, pl. xi. fig. 11). But the crop is longer and narrow, and in the ventriculus immediately behind the two anterior cæca there is a deep constriction, below which the *ventriculus* is broad and spacious.

The Philopteri of Ducks, Geese, and Swans.

This interesting group of Mallophaga was first seriously tackled by Giebel in the 'Insecta Epizoa,' 1874 (**5**, pp. 113–116), in which eight distinct species are described, including the typical *Philopterus icterodes*. Denny (**8**, pp. 95 & 99) described two other species—*P. cygni* from *Cygnus bewicki* Yarr. and *P. chrysophthalmi* from *Glaucion clangula* (Linn.) (*Clangula chrysophthalmi*). By reference to Denny's collection, now in the British Museum, his "*D. chrysophthalmi*" proves to be an Accipitrine parasite, probably *P. pictus*, a straggler perhaps upon the Golden-eye Duck; or Denny may have misread or confused his label, mistaking "Golden-eye" for "Golden Eagle." Giebel remarks, of the form figured and described by Denny under the name "*D. icterodes*," that "seine Abbildung giebt so erhebliche Differenzen an, dass man gerechte Zweifel an der Identität erheben könnte." I have examined Denny's specimens, and find, as Giebel suspected, that Denny did not have *P. icterodes* before him. His specimens belong to the form which, until the types of Giebel and Nitzsch can be re-examined, I propose to identify with Giebel's *P. ferrugineus*. Piaget (**3**, pp. 113–116) was imperfectly acquainted with these Duck parasites. He describes and figures true *P. icterodes*, I think correctly, although the sketch of the terminal segments of the abdomen of the male (pl. x. fig. 1 *a*) appears to show the remarkable structure on the endomeral plate described below and called the effractor, which is present in *P. ferrugineus* but absent in *P. icterodes*. Piaget did not know any of Giebel's species, and subsequent authors have labelled all Philopteri from Geese and Ducks *P. icterodes*.

Through the generosity of Mr. Waterston I have been able to prepare, dissect, and mount a considerable number of Philopteri of this group from a variety of hosts, the following distinct species emerging as a result:—*Philopterus cygni* D. (on Swans), *P. brunneiceps* G. (on Geese), *P. icterodes* N. (on different species of Ducks), *P. ferrugineus* G. (on Ducks), *P. obtusus* G. (on *Somateria mollissima* (Linn.)), and a species taken on the Pochard, which I cannot name satisfactorily and must therefore regard as new.

The whole group, for which the new genus *Anatœcus* is proposed, is a remarkably compact one, and the species comprised in it are all closely related and sometimes with difficulty differentiated one from another; so that Giebel's specific diagnoses are of little assistance, even for the purposes of identification. Further, as straggling occurs so frequently from Duck to Duck, it is unsafe to rely for help upon the host's name.

The above identifications, therefore, must be accepted with reserve. Rather than give new names, it has appeared better to perpetuate the old where that was possible, at the same time figuring the parts important for the differentiation of the species. In the future, should the types of Giebel and of Nitzsch become accessible, these decisions can be revised if necessary.

ANATŒCUS, gen. nov.

Head distinguished by the characteristic alation of the clypeus, by the presence of two small peg-like spines dorsally (one on each side of the posterior apex of the signatural plate *), by the unusually short antennæ, and the modified lyriform organ. Abdomen characterised by the form of the lateral tergites, which in segment 1 meet each other in the middle line. In subsequent sections, except the last, the tergites leave an uncovered median field. In the male copulatory apparatus, the fusion of the parameres distally with the pseudopenis, the form of the latter, the endomeral plate, and sac are also good generic characters. Finally, the form of the *vesicula seminalis* and the extremely short *ductus* must be included.

Small ectoparasites, infesting Swans, Geese, and Ducks.

A genus indicating in the male genitalia certain Lipeuroid affinities, and in the mouth-parts obvious affinities with the genus *Ibidœcus*, nov.

Genotype: *Anatœcus icterodes* Nitzsch.

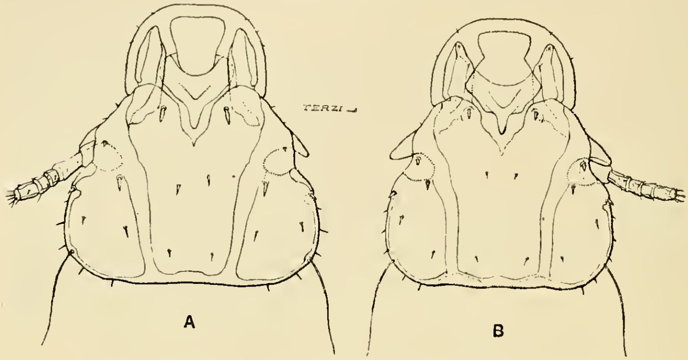
The six species distinguished up to the present (no doubt others remain to be elucidated) fall into two groups, according as the *effractor*—a remarkable structure shaped like a tin-opener—is present or absent on the endomeral plate of the male. A. Those with the "tin-opener" are *A. ferrugineus* and *A. obtusus*. B. Those without it are *A. cygni*, *A. icterodes*, *A. brunneiceps*, and *A. difficilis*, sp. n.

* The whole of the dorsal chætotaxy of the head is a generic character.

In the same genus should be included *Docophorus brunneopygus* Mjöberg (**6**, p. 130) on *Anser leucopsis*, which I do not know.

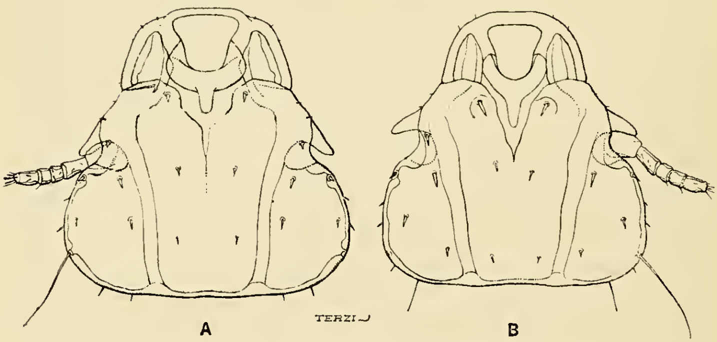
A. difficilis, sp. n., closely resembles *A. ferrugineus* in form, with the one considerable difference that the "tin-opener" is absent.

Text-figure 7.



A. *Anatœcus ferrugineus*, ♂. B. *A. icterodes*, ♂. × 80.
Compare the signatures.

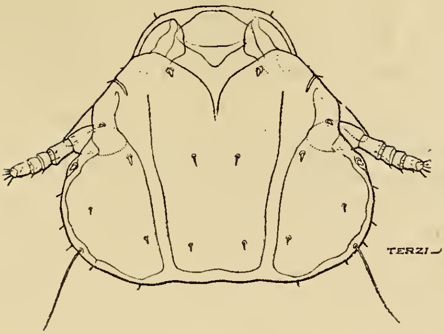
Text-figure 8.



A. *Anatœcus obtusus*, ♂. B. *A. brunneiceps*, ♂. × 80.
Compare the signatures.

Text-figs. 7, 8, & 9 illustrate the form of the head in these species, and the table presents a comparison of the head-measurements (millimetre scale). In the table the measurements taken are from the posterior apex of the signature to the anterior margin, and transversely from one lateral margin to the other at the level of the base of the clypeal bands, together with the total length and the greatest breadth.

Text-figure 9.



Anatœcus cygni, ♂. × 80.

Head-measurements (millimetre scale) of Males of Anatœcus *species.*

	Group A.						Group B.					
	A. ferrugineus.			*A. obtusus.*			*A. cygni.*		*A. icterodes.*		*A. brunneiceps.*	
	1.	2.	3.	1.	2.	3.	1.	2.	1.	2.	1.	2.
Breadth	·40	·41	·40	·46	·46	·45	·49	·50	·38	·38	·42	·40
Breadth in front	·20	·20	·19	·25	·24	·25	·22	·20	·22	·23	·18	·20
Length	·41	·43	·40	·46	·45	·45	·41	·40	·41	·41	·43	·41
Length in front .	·19	·19	·19	·18	·16	·17	·10	·10	·16	·16	·14	·14

In addition to the differences in the form of the head, in the cephalic index, and in the male copulatory apparatus, small specific characters may also be seen in the colour (rather variable, however), in the shape of the abdomen, and the genital mark in the male.

The Society's Collection contained two or three specimens of the typical *A. icterodes*.

ANATŒCUS ICTERODES Nitzsch. From *Aex galericulata* (Linn.).

The Mouth-parts. (Text-fig. 10.)

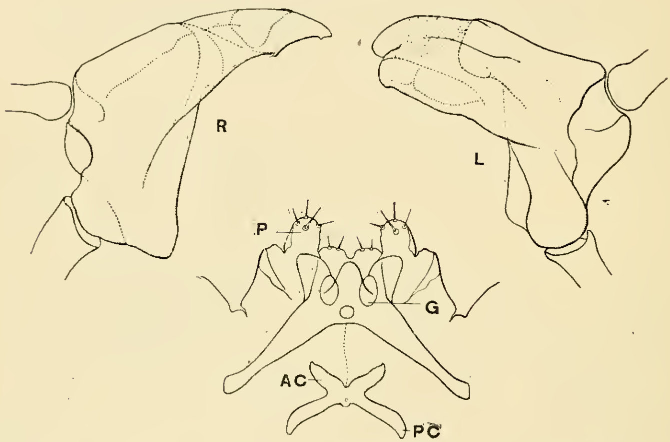
Mandibles.—In *A. cygni* and *A. icterodes*, and probably throughout the genus, the narrow basal process of the left and the quadrangular process at the base of the right mandible are absent, the shape of the mandibles being accordingly different.

These processes occur and have been described in many species of Mallophaga, both Amblycera and Ischnocera (see Part I. and some of Kellogg's figures, Proc. Cal. Acad. Sci. vol. vi., 1896). I find them absent not only in *Anatœcus*, but in the genus *Ibidœcus*, nov. (see p. 664) and in *Boöpia tarsata*—probably absent in other Boöpidæ as well.

The lyriform organ and "glands" are modified throughout the genus, and resemble those of *Ibidœcus* figured on p. 670. The text-figure shows their typical form.

A. icterodes.—Both *mandibles* are very similar, the right differing from the left in the acuteness of the apices of its two branches. In the right there is a minute protuberance subapically on the ventral branch and another lower down on the cutting-edge. There are a few transverse ridges distally on the

Text-figure 10.

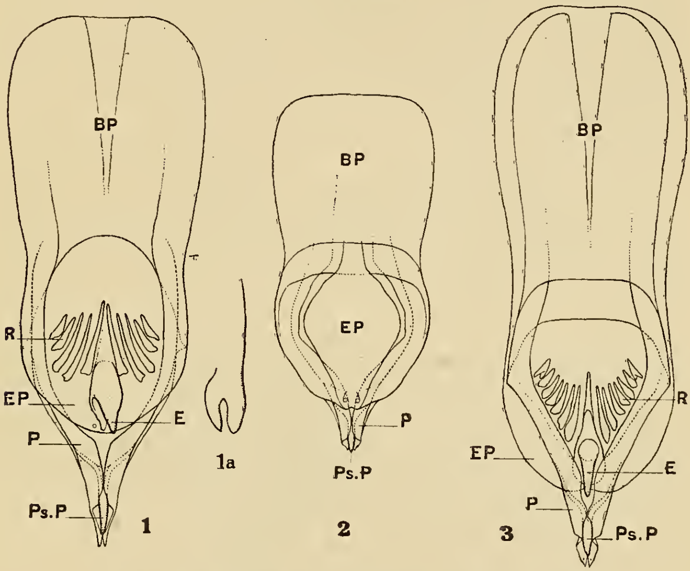


Anatœcus icterodes. Mouth-parts. × 400. Maxillary lobes not shown.
R. right, and *L.* left mandibles. *P.* "paraglossa." *AC.* anterior cornu, and *PC.* posterior cornu of lyriform organ. *G.* "gland."

dorsal surface of the dorsal branch and a V-shaped groove, the lower margin of which curves inwards and then downwards, showing a notch in its margin just before the latter slopes inwards in a straight line. *Labium*: This has clearly demarcated lateral margins, formed of stronger chitin than the immediately surrounding area. "Paraglossæ" short, with long terminal spines. Inner pair of lobes well defined. *Isopogometric apparatus*: The two sprawling posterior cornua of the lyriform organ run in a dorsal direction, one on each side of the pharynx. The anterior cornua are two short broad processes, rounded in front. The lyriform organ is small and thinly chitinised, invisible without dissection. *The basal pieces* (*or* "*glands*") are small circular areas, each framed in a chitinous plate which goes forward to the labial margin as anterior hypopharynx. Posteriorly are attached the usual narrow tendons, one to each "gland." "Ducts" or chitinous chords apparently absent.

A. cygni.—In the form of the mandibles, lyriform organ, basal pieces, anterior hypopharynx, and in the absence of ducts this species agrees closely with the preceding, and I am unable to find any obvious differences. The mandibles are perhaps more powerful.

Text-figure 11.



Male copulatory apparatus of the genus *Anatœcus*. × 150.

1. *A. ferrugineus*. 2. *A. cygni*. 3. *A. obtusus*.

BP. basal plate. *R*. retinacular comb. *EP*. endomeral plate. *P*. paramere. *Ps.P*. pseudopenis. *E*. effractor. 1*a*. side view of effractor.

The small sac cannot be shown.

The Male Copulatory Apparatus in the Genus Anatœcus. (Text-figs. 11 & 12.)

Group A. Those *with* the effractor.

A. ferrugineus.—*Basal plate*: Longer than broad, with a rather deep and broad V-shaped white mark debouching on the anterior margin, looking like a split, the result of an accident in dissection;

it is present in all the species except *A. cygni*. The plate and parameres are fused in one piece, there being no articulation and no trace even of a suture. *Parameres*: Distally these appendages bend in to meet one another and embrace the median pseudopenis, which is probably endomeral. The parameres are fused with the base of the pseudopenis, but not with one another, the tips being quite discrete. Parameres and pseudopenis lie dorsally and curve upwards at the end. Below, in the mesosomal space, is the *sac*—an interesting structure, slightly expansible (in copulation), and carrying dorsally at its distal end a great number of minute finger-shaped papillæ. Behind these are seen numbers of minute circular spines. On its ventral surface in the hypomeral area is a remarkable retinacular apparatus, consisting of a semicircular row (with the apices pointing backwards) of ten elongate powerful teeth, those in the middle as long as the pseudopenis; it is uncertain whether this comb of teeth can be moved forward or not. Below the sac is the *endomeral plate*, which, like the parameres, is continuous with the basal plate. Fixed upon the posterior margin dorsally is the densely chitinised effractor. It is a little, more or less oval piece of dark-brown shiny chitin, running out into two limbs behind—a dorsal and a ventral, the one immediately above the other. The ventral limb is blunt at its tip, the dorsal more acute, the two together recalling a tin-opener without the handle.

A. obtusus.—Very similar to the apparatus of the preceding species, so that it is sufficient to signal the differences. The basal plate is different in shape in the neighbourhood of the effractor; the teeth of the retinacular comb are shorter and more numerous, being fifteen or sixteen or more in number; and, lastly, the effractor has a different shape, being distinguished by the narrower and more elongate dorsal limb, which is set in the ventral process of pyriform outline as in a sort of pedestal.

Group B. Those *without* the effractor. Correlated with its complete absence, is the complete absence of the retinacular comb.

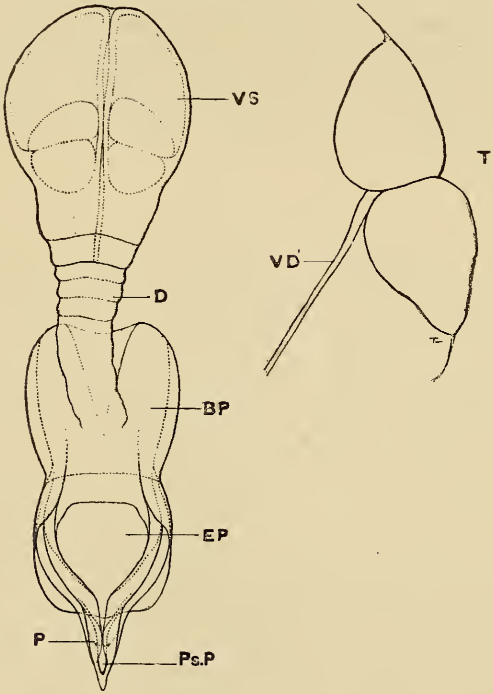
A. cygni.—*Basal plate*: Short and broad, posterior V-shaped mark absent. *Parameres*: Broad at the base, at the apex blunt and fused closely with the pseudopenis, which is quite short. Two minute white circles on the posterior margin of the endomeral plate—probably the relatively large alveoli of minute sensory hairs.

A. icterodes.—*Basal plate*: Short and broad; the V-shaped mark present. *Parameres*: Longer than the basal plate, and enclosing a space of different shape from that of *A. brunneiceps*, with which it must be compared.

A. brunneiceps.—In this species the apparatus, very similar to the preceding, is nevertheless characterised by the possession of an elongate, thin, chitinous splint lying dorsally on the sac and projecting a little beyond it. This probably is the penis, and is particularly easy to see in some specimens from *Somateria mollissima* *.

A. difficilis, sp. n.—The penis-splint is present. The apparatus appears to me to be quite indistinguishable from the preceding.

Text-figure 12.



Anatœcus icterodes. Male reproductive system and copulatory apparatus. × 160.

VS. vesicula seminalis. *D.* ductus. *BP.* basal plate. *EP.* endomeral plate. *P.* paramere. *Ps.P.* pseudopenis. *T.* testis. *VD.* vas deferens.

Sac not shown.

Male Reproductive System in Anatœcus. (Text-fig. 12.)

This was examined in *A. icterodes* and *A. brunneiceps* and found to be the same. It is noteworthy for the extremely

* It may exist in other species and yet escape detection, if the chitin be hyaline and transparent.

short ejaculatory duct, the large testes, and the curious locular character of the *vesicula seminalis*, which, as usual, consists of a right and a left ventricle fused into an organ of the shape seen in the text-figure.

The Philopteri of Storks and Ibises.

Two new genera are diagnosed below—the one represented by *Philopterus tricolor* N. and found upon the Ciconiidæ, and the other represented by *P. plataleæ* D. and found upon the Ibididæ. These two genera stand fairly close to one another. *Ibidœcus*, gen. nov., contains the species designated "Bisignati" by Piaget and characterised by the large double signature; *Neophilopterus*, gen. nov., contains the forms which Piaget collected under the heading "Setosi," and is characterised by the fusion of the double signature into one plate. Other well-defined characters are recounted under the respective diagnoses of these two genera.

Neophilopterus, gen. nov.

Head, especially in the female, relatively small; on the dorsal surface of the pre-antennal area, a transverse suture marks the posterior margin of the signature. In the new genus *Ibidœcus* each element of the double signature ends behind in an acute angle. In the present genus two acute angles are present posteriorly, suggesting fusion of an originally double plate *. Each of these posterior angles is situated more laterally than in *Ibidœcus*, and the plate on each side extends further, so as to overlie the clypeal band so prominent in *Ibidœcus*. By focussing down, the clypeal band is seen crossing the suture and thus uniting the clypeal region with the skull (as in other *Philopteri*). Thorax longer than broad, with a strong, transverse, acetabular bar running in from each side between the first and second pairs of legs and giving attachment to the former. Clavicles present. Abdomen with two transverse rows of silky hairs on the tergum of each segment. Two tergites on each segment situated laterally and leaving a bare median field except in the terminal segment, where they meet across the middle. The male copulatory apparatus is also fairly characteristic, and may probably prove diagnostic for the whole genus.

Genotype: *N. tricolor* Nitzsch (**5**, p. 96).

Parasites of the Ciconiidæ.

The following good species can with certainty be referred to this genus:—*N. tricolor* N., *N. indicus* P., *N. incompletus* N., *N. unifasciatus* P., and *N. episcopi* Kellogg.

Neophilopterus incompletus Nitzsch (**5**, p. 97).

This is the only member of the new genus included in the

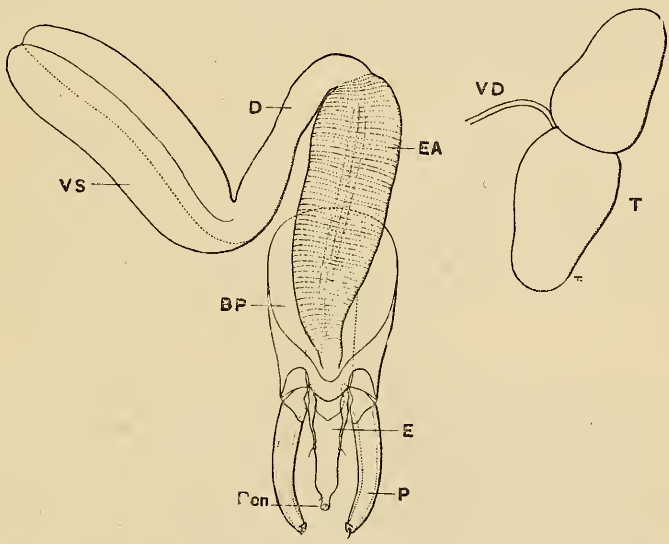
* I have no evidence to show that *Neophilopterus* is a derivative of *Ibidœcus*. Evolution, therefore, may have gone the other way.

collection. It was represented by many specimens from *Euxenura maguari* (Gmel.).

Giebel described a *Neophilopterus* from this same host, calling it *N. subincompletus*. But to this species, so far as it is possible to understand it from Giebel's description, the present specimens do not belong.

Male Reproductive System (text-fig. 13).—Testes pyriform as usual. The *ductus* is short, there being only two bends in it from the mesosome to the vesicula. The *vesicula seminalis* is elongate, narrow, with a longitudinal median groove indicating the double origin of this organ. The ductus, on leaving it, bends backwards for a little way, and for this portion of its length the duct is a fairly narrow canal. On turning forwards again after the second bend, it expands into a large canal quite

Text-figure 13.



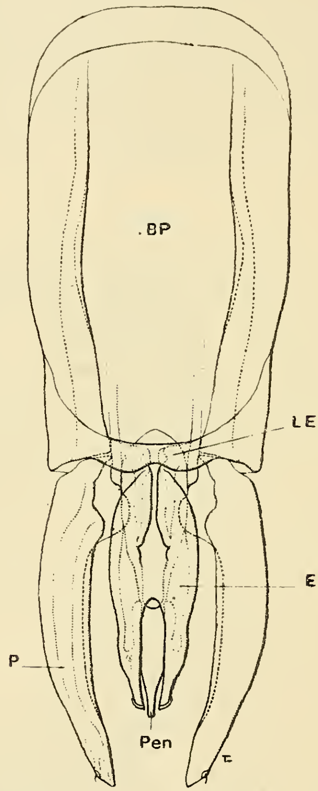
Neophilopterus incompletus. Male reproductive system and copulatory apparatus. × 100.

VS. vesicula seminalis. *D*. ductus. *EA*. ejaculatory ampulla. *BP*. basal plate. *E*. endomere. *Pen*. penis. *P*. paramere. *T*. testis. *VD*. vas deferens.

as broad and long as the *vesicula* itself, and no doubt functioning as an ejaculatory ampulla, as its walls are well supplied with transverse muscle-fibres, which run in from opposite sides and appear to become plaited together in the middle.

Male Copulatory Apparatus (text-fig. 13).—*Basal plate*: Longer than the parameres, broader behind than in front, posterior margin very convex. Each lateral margin has a broad band. Between these lateral bands the median area of the plate is trough-shaped. Just behind the mesosome lies a small median plate, which sends off a branch on each side behind into each lateral region of the basal plate. *Parameres*: Quite evenly rounded rods, tapering somewhat towards the distal end and curving slightly inwards. *Mesosome*: Fused into one piece, shaped as in text-fig. 16. Half-way down on each side, projecting in a forward direction, is

Text-figure 14.



Neophilopterus tricolor. Male copulatory apparatus. × 140.
BP. basal plate. *LE*. lower endomere. *E*. endomere. *P*. paramere.
Pen. penis.

a strong bristle set in a well-marked alveolus. These two bristles mark the end of the endomeral portion of the mesosome; between it and the distal half or telomeral portion a distinct suture can be observed. In the dissection of a new species of the genus collected on *Carphibis spinicollis* (Jameson) the endomeral or proximal half of the mesosome is large; the two forwardly-directed spines are present, one on each side at its posterior end; while the distal or telomeral half, strongly chitinised, is telescoped up within the endomeral. Similarly with another new species from *Abdimia abdimii* (Licht.).

Comparison with the Apparatus of Neophilopterus tricolor (text-fig. 14).—This apparatus, while resembling the preceding in its basal plate and parameres, differs from each of the three forms mentioned above in features of the mesosome and in the presence of a small process or plate at the base of the mesosome which I regard as an upper endomeral chitinisation. The part marked *Pen.*, apparently telomeral, is white and more or less membranous, and appears to be held by the basal endomeral portion shaped something like a pair of pincers.

The Receptaculum Seminis of the Female of N. incompletus (text-fig. 21 (3), p. 672).—This should be compared with the *receptaculum* of *Ibidœcus* (text-fig. 21 (1 & 2)). From a minute opening into the genital cavity, a delicate narrow duct runs up to a large semicircular sac borne upon a short circular calyx, brown in colour, with its rounded outer surface longitudinally striate.

Mouth-parts of N. tricolor *and* N. incompletus.—It is worthy of record that, while the lyriform organ and basal pieces of *N. incompletus* are normal, in *N. tricolor* the same parts are greatly modified. The lyriform organ resembles that of *Ibidœcus plataleæ*. Reference to the isolated modification of the isopogometric apparatus in species of certain genera is referred to in Part I. of this paper (p. 273), and is again discussed further on, where the genus *Ibidœcus* is discussed.

IBIDŒCUS, gen. nov.

Head with a double signature, consisting of two oblong plates, each plate usually with a small embossed area on the posterior end, which runs out into an angle. Clypeal bands very well marked; behind, they pass beneath each signatural plate and inwards to be attached to the skull. Antennæ long, with an especially long second segment. Abdomen large, broad, with a lateral tergite on each side of each segment, so as to leave a clear median area. A single row of hairs across the tergum of each segment.

Genotype: *Ibidœcus plataleæ* Denny (**8**, p. 100).

The type of Denny's species is in the British Museum.

The following species can certainly be referred to the new genus:—*I. hians* G., *I. bisignatus* N., *I. longiclypeatus* Piaget, and *I. bimaculatus* Mjöb.

The collection of the British Museum contains several undescribed species, including one from that interesting South-American bird, *Aramus scolopaceus*.

Neophilopterus and *Ibidœcus* appear to be related rather closely.

IBIDŒCUS PLATALEÆ Denny.

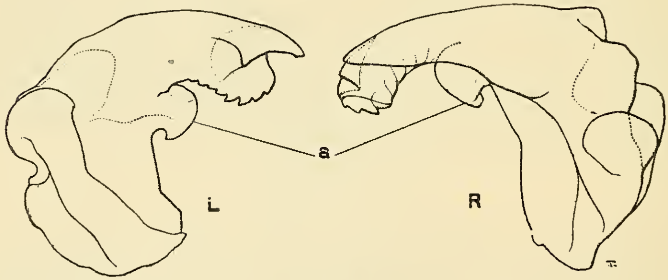
A single female among some *Colpocephalum* material from *Ibis molucca* Cuv. (*I. strictipennis*)—a straggler, probably, as *I. plataleæ* parasitises *Platalea leucorodia* Linn. The observations which follow were made on specimens kindly lent by Mr. Waterston.

Male Reproductive System.—This closely resembles that of *I. flavus*, sp. n., about to be described. The elongate form of the *vesicula* may prove to be a generic character.

Through lack of material, the male copulatory apparatus cannot be satisfactorily described here.

Mouth-parts.—The modified isopogometric apparatus was described and figured in 1913 (**9**, p. 135, text-fig. 27) for this species under the name *Docophorus sphenophorus*. The *mandibles* are very interesting on account of their large size, the absence of basal processes in each mandible, and the unusual development of the curious process shaped like a bird's head on the cutting-edge halfway up between the tip and the base of each mandible (see text-fig. 15). The mandibles of the genus *Ibidœcus* resemble

Text-figure 15.



Ibidœcus plataleæ. Mandibles. × 180.

L. left. *R.* right. *a.* avicularian process.

closely those of the genus *Anatœcus* not only in the avicularian process, in the absence of basal process and quadrangular process, but in the distal extremities consisting each of two apices with one ridged. The species *I. plataleæ* is distinguished by the size and prominence of the avicularian process* and in the large size of the ridges, which in side view give the tip of the mandible longitudinally a serrate appearance. When dissected out and placed face downwards on its cutting surface, the mandible is found to be as deep dorso-ventrally as it is long from base to apex.

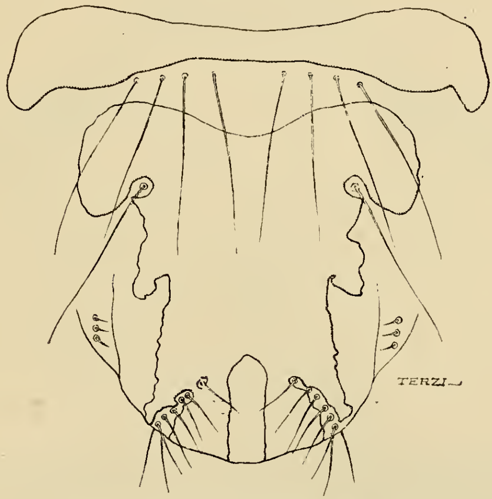
* *Cf.* avicularia in the Polyzoa.

IBIDŒCUS FLAVUS, sp. n.

This species does not form part of the collection on which the report is based, but for the purpose of comparison it is useful to include it here, especially as many specimens—male, female, and larvæ—are available for study, being part of a valuable consignment of Mallophaga presented to the British Museum by the Hon. N. C. Rothschild.

I. flavus was collected on *Platibis flavipes* (Gould) (the Yellow-billed Spoonbill of Australia) from "Serpentine, Melbourne," on August 3rd, 1911, the label being endorsed "A. Coles." It is a handsome yellow parasite, recognisable by the shape of the pre-antennal region of the head, which is longer than in *I. plataleæ* and more truncate at the front margin, but not so long as in *I. hians* and the other members of the long-headed section of the genus. The male genital plate is also a ready means of identifying this form (text-fig. 16).

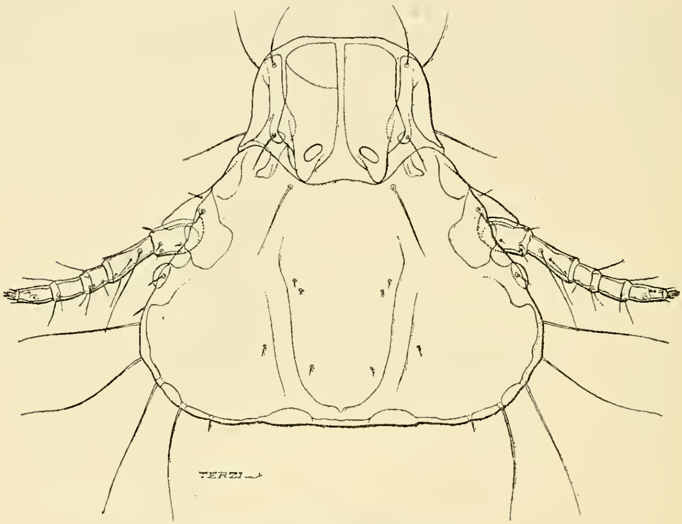
Text-figure 16.



Ibidœcus flavus. Male genital mark. × 90.

External form.—MALE. *Head* (text-fig. 17): Large; pre-antennal region elongate, each signatural plate long, parallel-sided. Line of the temple from the antenna to the anterior lateral angle of the pronotum very convex. Occipital line straight, an exoccipital thickening on each side. Two dark brown, slightly diverging rafters run across the roof of the skull. A small gular plate present, in front gracefully narrowing to an acute apex. A single median occipital apodeme running into the prothorax. Tentorium absent. *Thorax*: Much narrower than the head, almost parallel-sided and rectangular. Spiracle opens laterally just beneath the posterior lateral angle. Clavicles present, each running as a narrow rod from halfway down the lateral margin inwards and downwards to project beyond the hind margin into the metathorax as a broad band, which curves down and then forwards again to be inserted into the transverse acetabular bar behind the first pair of coxæ. The nota of both segments are divided by a median longitudinal colourless line. *Abdomen*: Regularly ovate. The terminal tergite forms a deep semicircular band around the genital opening. Ventrally, the genital plate with its chætotaxy forms an easily recognisable mark (see text-fig. 16).

Text-figure 17.

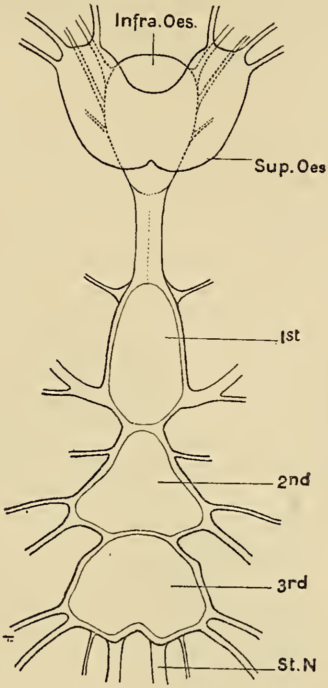


Ibidœcus flavus. Head of male.

External form.—FEMALE. As in the male, except for the usual sexual differences of the abdomen.

Chætotaxy.—For differentiating species, the chætotaxy in this genus probably will prove of little value, as it is almost identical in the male and female both of this species and of *I. plataleæ* (except for the usual sexual differences at the end of the abdomen). For example, on the second segment of the antenna there is one elongate bristle and a shorter one beside it; the signatural plates are bare dorsally; on the ventral surface is a single bristle in the middle of each plate. On the clypeal band at the base there is one bristle dorsally, one projecting laterally, and one on the ventral surface. At the distal end of the band there are three more bristles similarly arranged. In both sexes of both species, also, there is a bristle on the dorsal surface of the skull just behind the posterior acute angle of each signatural plate, a spine on the corneal surface of each eye, and a spiny hair behind and the same minute spines dotted sparsely over the postantennal dorsal area *. The chætotaxy of the abdomen calls for no special mention.

Text-figure 18.



Ibidœcus flavus. Central nervous system.

Infra.Oes. infra-œsophageal ganglion. *Sup.Oes.* supra-œsophageal ganglion. 1*st*, 2*nd*, 3*rd*. thoracic ganglia. *St.N.* stomatogastric nerves.

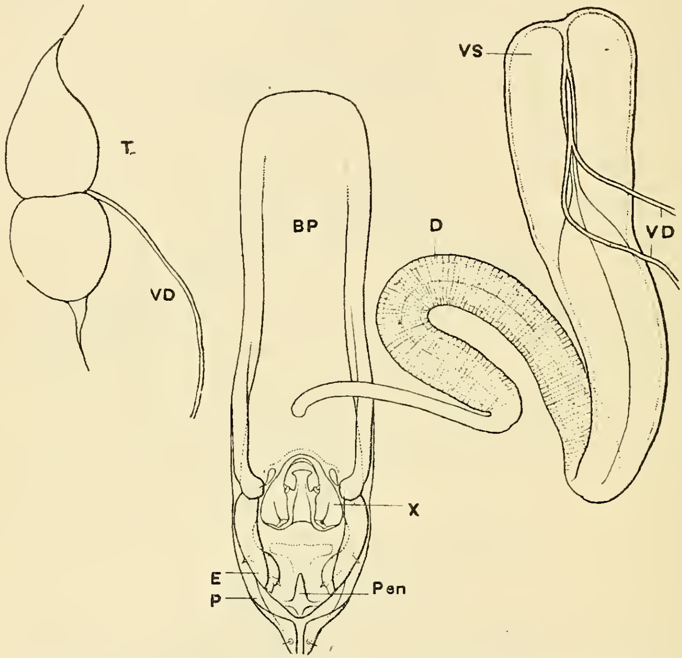
Alimentary Canal.—Mr. Waterston has pointed out to me some minute teeth on the chitinous lining of the pharynx in a *Læmobothrion*. Similar pharyngeal teeth in *Lipeurus ferox* were figured without comment in 1913 (**9**, p. 131, text-fig. 24). I now find similar teeth in the pharynx of other genera, including the present species, in which they are very minute and occur in small rows, each tooth directed backwards. The patch of teeth in the anterior cæcum of the crop is present in its usual extent; and the

* It is likely that the chætotaxy, at least of the head, just as in *Anatœcus*, will prove to conform to the same plan throughout the whole genus. It is the same in two other species (unnamed) which I have examined, making four in all.

rest of the alimentary tract requires no detailed description, except perhaps a reference to the swollen base of each Malpighian tube.

Nervous System (text-fig. 18).—The state of preservation forbade any satisfactory dissection of the nervous system. The brain and main ganglia have been figured by Snodgrass for *Eurymetopus taurus* (**1**, pl. xvi. fig. 7). From this, the central nervous system differs in its general form. The supra-œsophageal ganglion is

Text-figure 19.



Ibidœcus flavus. Male reproductive system and copulatory apparatus. × 90.

T. testis. *VD.* vas deferens. *BP.* basal plate. *E.* endomere. *P.* paramere. *Pen.* penis. *D.* ductus. *VS.* vesicula seminalis.

much broader and the bay in front less deep. The sub-œsophageal is narrower; the first thoracic ganglion is also long and narrow and a little narrower in front than behind. The second or mesothoracic ganglion is roughly triangular in shape, the apex pointing forward. The metathoracic is the largest of the three, and more or less circular in shape. Behind, two extraordinarily large stomato-gastric nerves come off and supply the viscera.

Male Reproductive System (text-fig. 19).—*Testes*: Relatively small, the commissure between them weak, so that in dissection the two are commonly separated *. *Vesicula seminalis*: This is a long narrow sac, with the usual longitudinal median division. The anterior end is a little truncate, broader than it is behind, where it decreases almost to the bore of the issuing ductus. *Ejaculatory ampulla* absent or only slightly developed.

Male Copulatory Apparatus (text-fig. 19).—*Basal plate*: Lateral margins well chitinised, parallel-sided except for the posterior third of their length, where the plate broadens out. Posterior margin concave. *Parameres*: At the base these are broad, thin, and transparent bands which fold in around the stout densely chitinous endomeres. Distally, the parameres curve in towards one another, so as to embrace the tip of the remarkable penis. Beyond the end of the penis they are produced forwards and become more strongly chitinous and brown in colour. Subapically, on the outside margin of each, there is a small directive hair. *Endomeres*: These remarkable appendages are much shorter than the parameres, strongly chitinised, deep brown in colour, and slightly curved, the convex side of the curve being on the outside of their length. The distal end is enlarged and displays two large ridges, forming distinct cutting-edges, each ridge with a separate apex. Between the distal ends lies the main body of the penis. At the base they articulate with almost the whole articular surface of the posterior lateral angles of the basal plate. *Mesosome*: The penis is a large bulky piece of chitin, the form of which is delineated in the text-figure. Behind it lies the curiously-shaped piece labelled X. This is clearly endomeral—whether upper or lower, I am not prepared to say. The outline of the central portion of this piece is shaped something like a bowl on a pedestal. There are two long backwardly projecting spines, one on each of the two outwardly curving cornua: and behind, on each lateral angle at the base of the bowl, a short peg-like spine.

Measurements (*millimetre-scale*).

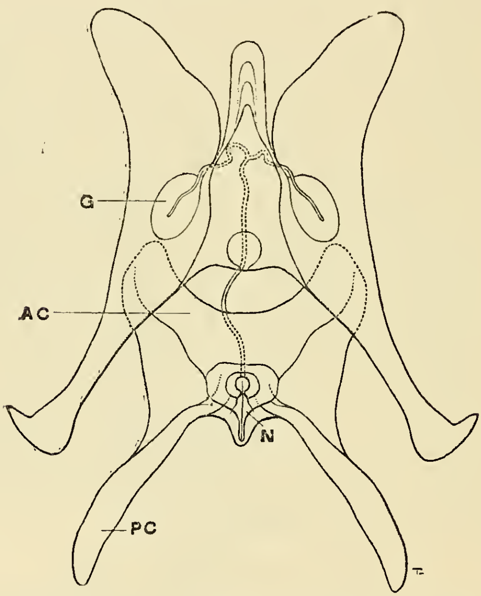
	Length.		Greatest Breadth.		Length of Antenna.		
	♂.	♀.	♂.	♀.	Segment.	♂.	♀.
Head …………………	·965	·96	1·00	1·16	1.	·09	·10
Pro- } thorax ……	·60	·80	·65	·74	2.	·14	·17
Meta- } thorax			·90	1·05	3.	·08	·07
Abdomen …………	1·28	2·20	1·30	1·85	4.	·09	·08
					5.	·095	·09
Total ………	2·845	3·96			Total …	·495	·51

* Perhaps due to the condition of the tissues.

The Mouth-parts in the Genus Ibidœcus. (Text-fig. 20.)

It is necessary to revert once more to the subject of the pharyngeal sclerite (or lyriform organ) referred to on p. 273 of Part I. and on p. 656 of the present instalment, inasmuch as within this single genus *Ibidœcus* may be found species with these organs modified (as they occur in scattered instances throughout the Order), at least one species in which the parts are normal as in most Mallophaga, and in the species *I. flavus* a valuable intermediate stage.

Text-figure 20



Ibidœcus flavus. Isopogometric apparatus. × 290.

G. "gland." *AC.* anterior cornu, *PC.* posterior cornu, and *N.* "nucleus" of the lyriform organ.

This isopogometric apparatus, as Armenante (**10**) called it (on the theory that it was a contrivance for measuring the barbules into equal lengths for cutting) *, was supposed by Snodgrass (**1**) to be absent in some Mallophaga, such as *Lœmobothrion*, *Ancistrona*, *Nitzschia*, *Physostomum*, *Trinoton*, and others. In

* The fact that a similar apparatus is present in the Psocidæ, which do not feed on feathers, does not necessarily disprove Armenante's theory, as its present function may be a new one, involving the adaptation of old parts. It is certainly difficult to believe that the so-called "glands" (now apparently wholly chitinous) were not once glandular, which they may still be in part.

1913 (**9**) I described them as present though modified in these five genera (and in others) and figured them, at the same time expressing the opinion that the apparatus was probably present throughout the Mallophaga. Up to the present, after many more dissections, there is no reason for changing this opinion. Recently (**11**, p. 393) Mr. Harrison has stated that the lyriform organ is "totally absent" in *Ornithobius*. But it is still present in this genus, though atrophied and very difficult to dissect out.

Although in such genera as *Læmobothrion*, *Menopon*, and *Colpocephalum* the apparatus shows differences in the lengths of the posterior and anterior cornua (often to a very great extent) and in the shape of the "glands," the characteristic form of lyriform organ and "glands" is preserved and is immediately recognisable. In the following Amblyceran forms, however, very extensive modifications have been brought about:—*Boöpia* and *Heterodoxus* (and probably the whole of the family Boöpidæ), *Gyropus* (probably all the Gyropidæ), *Pseudomenopon*, *Nitzschia*, *Trinoton*, *Tetrophthalmus* (belonging to the Menoponidæ), *Physostomum*, *Trimenopon*, *Ancistrona*. Among the Ischnocera, the following genera must be included:—*Ornithobius*, *Anatœcus*, most of the genus *Ibidœcus* probably, and the species *Trichodectes hemitragi* Cummings and *Neophilopterus tricolor*. Other forms, such as *Philopterus pertusus*, are indicated by Snodgrass, but these require investigation.

Modification proceeds by way of the gradual disappearance of the "nucleus" or rounded central portion of the lyriform organ, the reduction of the "gland" in size and its ultimate disappearance, and the transformation of "duct" and "glands" into hypopharyngeal sclerites. In text-fig. 20 is shown the lyriform organ of *Ibidœcus flavus* modified, but with the still persistent remains of the "nucleus," consisting of a clear "pinhole" surrounded by a circle of dense chitin. After bifurcating, each branch of the "duct" enters a small, delicate, oval "gland," which lies rather loosely encircled within a plate of chitin; this, behind, tails out in a narrow strip, and in front runs forward as a broad hypopharyngeal plate in outline shaped like a human thumb bent outwards with the "ball" of the thumb facing the corresponding structure on the opposite side. Between these two plates longitudinally runs a narrow chitinous strip, just as in *Lipeurus ferox* and others. A sheet of transparent chitin crosses between the two "glands," and in the centre of this may be seen a small circular clear space, possibly a hole.

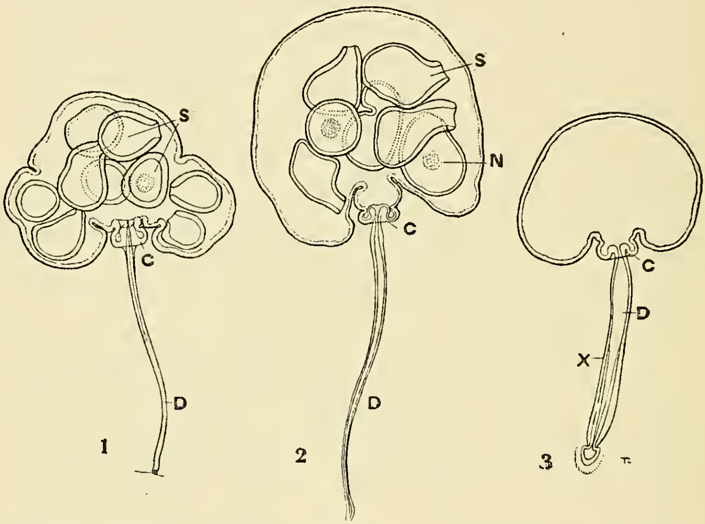
As compared with this apparatus, that of *I. plataleæ* is decidedly more modified, all sign of "nucleus" having disappeared; while in a species from *Aramus scolopaceus*, apparently undescribed, it is quite normal as in the majority of Mallophaga *.

* Mr. Harrison informs me that he possesses a species of *Ibidœcus* from an Australian host with a normal lyriform organ.

Spermatophores in Ibidœcus. (Text-fig. 21.)

Ibidœcus plataleæ.—The *receptaculum seminis* is an irregularly shaped sac at the end of an extremely fine chitinous duct which opens by a small aperture through the chitinous intima of the genital chamber. The duct is finer than in *Neophilopterus incompletus* and the calyx is of a very different shape, being bent back around the top of the duct. Inside the sac may be seen the spermatophores—hard, thick-walled follicles containing nests of spermatozoa. In some of these no opening could be discovered.

Text-figure 21.



Receptaculum seminis of 1. *Ibidœcus plataleæ*, 2. *I. flavus*, and 3. *Neophilopterus incompletus.* × 70.

S. spermatodome. *C.* calyx. *D.* duct. *N.* nest of spermatozoa.

Ibidœcus flavus.—The *receptaculum* resembles that of *I. plataleæ* and gives the same suggestion of a hydroid on its stalk. Just within the calyx, however, the canal opens into an atrium, absent in the preceding species. The flask-shaped spermatophores, five in one female and eight in another, lying loose and disposed irregularly, somewhat recall the form of the spermatophore figured by Von Siebold (**13**) for the Locustid *Decticus verrucivorus*, but the mouth is much larger and the neck broader. In each spermatophore in the first specimen was a nest of spermatozoa. In the second they were absent and had probably been discharged.

Cholodkovsky (**14** and **15**) divides the spermatophores in insects into four distinct types—(1) True spermatophores arising from the sexual organs of the male and facilitating the transference of spermatozoa into the female organs. Outside the Insecta this is the typical spermatophore well known by zoologists to occur in Urodeles, Cephalopods, Decapods, Myriapods, and elsewhere. Among insects true spermatophores are possessed by *Grillus* (**16**), *Dytiscus marginalis* (**17**), and others. (2) Spermatodosen or structures which arise in the female sexual organs and serve "zur Dosierung des Samens bei der Befruchtung der abzulegenden Eier." To this group belong the flask- and retort-shaped bodies in the *receptaculum seminis* of many Locustids, where they were first discovered so long ago as 1791 by Gabriel Brunelli (**18**), and first accurately described by Carl T. von Siebold in 1845 (**13**) in *Decticus verrucivorus*. To this category belong also the spermatophore-shaped structures discovered by Cholodkovsky in Trichoptera (**19**) and the "spermatophores" of certain Lepidoptera. (3) Spermatophragmen, or masses of gland secretion, serving as a medium for the transference of the spermatozoa from the male to the female, for the maintenance of the spermatozoa during copulation, or for the closing up of the female genital opening. Examples: some Locustid females and the "Sackchen" of *Parnassius*. (4) Spermatodesmen * or bundles of spermatozoa united to form feather-shaped structures, and so on.

The so-called spermatophores of the Mallophaga are *spermatodose*, and were discovered in *Lipeurus jejunus* by Kramer in 1869 (**12**), in a valuable and careful memoir which has since been neglected by writers on the Mallophaga as well as by Cholodkovsky, Ballowitz, Blunck, and others engaged in the study of insect spermatophores. Kramer noticed a number of flask-shaped vessels lying loose in the *receptaculum seminis* of the female, and as they were too large to permit of their passage up the narrow chitinous duct, Kramer concluded that they arose within the *receptaculum*, and claimed to have detected the necks of half-formed flasks in a special layer of epithelial cells within the *receptaculum*.

Cholodkovsky's summary of the reasons for thinking that these interesting spermatodose arise within the female is very suggestive, and it is to be hoped that the problem may be satisfactorily elucidated by an examination of further parasites from the Zoological Gardens, well fixed and carefully preserved.

Rather than be classed under the general term *spermatophore*, the three new terms introduced by Cholodkovsky should be used in contradistinction to it, spermatozeugma being substituted for spermatodesmen.

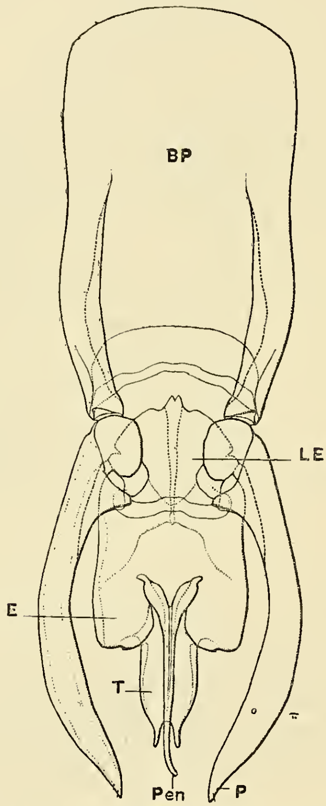
The Philopteri of *Numenius*.

Henry Denny, who, with Nitzsch and Giebel, shares the honour of laying the foundations of our knowledge of the Mallophaga, describes in his remarkable Monograph of British Lice, published in 1840, two species of *Philopterus* from the Curlew (*Numenius arquata* (Linn.)), viz. *P. testudinarius* and *P. humeralis*. In

* This is the spermatozeugma of Ballowitz (**20**).

'Les Pédiculines' (1880, p. 83), Piaget allows *P. testudinarius* to stand, and after stating that he does not know *D. humeralis* D., goes on to say "je n'ai jamais rencontré sur cet oiseau que le *testudinarius* dont je joins ici la description." The types of these two species, now in the British Museum, prove them to be perfectly distinct. Both species occur commonly on *both* the Curlew (*Numenius arquata*) and the Whimbrel (*N. phæopus*); the characters of *P. testudinarius* are divergent from the rest of its allies and necessitate the constitution of a new genus.

Text-figure 22.



Philopterus humeralis. Male copulatory apparatus. × 120.

BP. basal plate. *LE.* lower endomere. *E.* endomere. *T.* telómere. *Pen.* penis. *P.* paramere.

PHILOPTERUS HUMERALIS D. (8, p. 88). (Text-fig. 22.)

One ♂ from *Numenius arquata* (Linn.).

Male Copulatory Apparatus.—Basal plate: The anterior half is brown, flat. The posterior half possesses well-marked lateral margins, with a transverse band across the base. *Parameres*: Elongate curved rods, in cross-section circular. At its base each paramere possesses a large circular condyle which is turned inwards like the head of the femur in man. In front it is articulated with the posterior lateral angles of the basal plate, and behind, it lends a surface for attachment to the mesosome. *Mesosome*: The upper endomere consists of two square "wings"; each "wing" has a straight outer lateral margin and a characteristic "nick" in the posterior margin, after which the margin curves inwards and backwards towards the forked base of the elongate penis. The lower endomere is a small plate lying between the condyles of the parameres. Under the penis is a median elongate piece, bifid at the tip, representing telomeral chitinisations.

DOLLABELLA, gen. nov.

The diagnostic characters are few, but sufficient. They are the shape of the head taken in conjunction with the tergites of the abdomen, which in both sexes stretch right across and are on each side fused with the pleurites. Philopterids living with *P. humeralis* on *Numenius*.

Genotype: *Dollabella testudinarius* Denny.

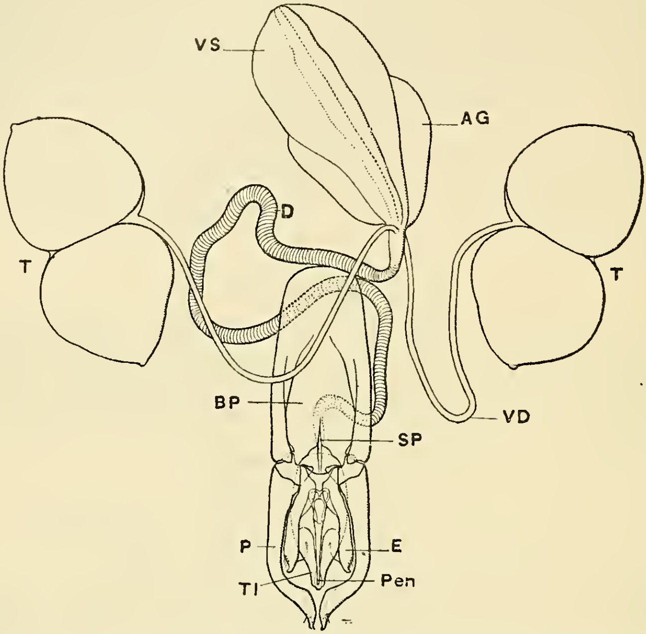
DOLLABELLA TESTUDINARIUS D. (8, p. 96). (Text-fig. 23.)

Several specimens from *Numenius phæopus* (Linn.).

Male Reproductive System.—In proportion to the *vesicula* the testes are very large, roughly pyriform, nearly as broad as long. The *vesicula seminalis* is elongate, pear-shaped, with a median longitudinal groove. The rather elongate accessory glands, one on each side, lie alongside of it in the posterior portion, and enter the top of the ductus. The *ductus ejaculatorius* is long and narrow, with several loops.

Male Copulatory Apparatus.—*Basal plate*: In front for a little more than a third of its length it is evenly chitinised and of a uniform brown colour. Behind, strong lateral margins with a clear membranous area between. At each lower lateral angle the articular surface is oblique, passing downwards from within outwards. A small angular process projects a little beneath the base of each paramere. *Parameres*: Slender, elegantly moulded rods, which a little after halfway turn inwards in a pronounced bend, and then run straight forwards to the distal end. The base of each paramere is characteristic in shape, being roughly quadrilateral, with two sharply defined posterior angles. Halfway down, in the middle of its dorsal surface a minute hair on each paramere; subapically on the outside another minute hair. *Mesosome*: This includes the endomeres, an upper and a lower, of complex form, the upper one possessing subapically on each of its two limbs two directive hairs in large alveoli. Between lies the penis, a rod with a large wing-like telomere on each side composed of rather transparent delicate chitin.

Text-figure 23.



Dollabella testudinarius. Male reproductive system and copulatory apparatus. × 75.

T. testis. *VS.* vesicula seminalis. *AG.* accessory gland. *D.* ductus. *BP.* basal plate. *SP.* median splint. *P.* paramere. *E.* endomere. *Tl.* telomere. *Pen.* penis. *VD.* vas deferens.

The Rest of the Philopteri.

The species of *Philopterus* in the collection remaining to be considered are five in number :—

Philopterus communis N. (**5**, p. 85).

A single ♀ in company with *Nirmus cyclothorax* N. from *Passer domesticus* (Linn.).

Philopterus semi-signatus N. (**5**, p. 80).

Two ♀ ♀. Host's name not given.

The difficult question of the Corvine *Philopteri* is discussed by Waterston (**21**).

Philopterus lari Denny (**8**, p. 89).

Five ♀ ♀ from *Numenius arquata* (Linn.). A straggler from Gulls.

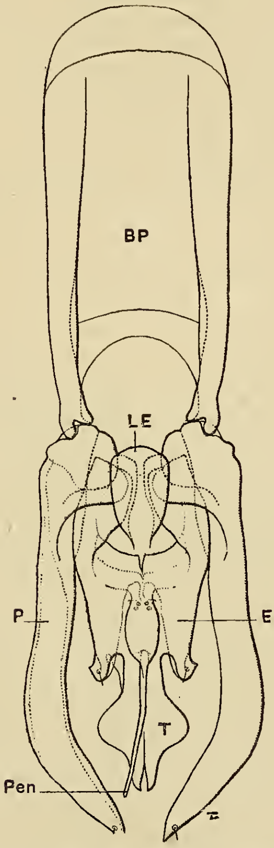
The male copulatory apparatus is figured by Snodgrass (**1**, pl. xiv. fig. 8).

Philopterus leontodon N. (**5**, p. 90).

A single male from *Psaroglossa spiloptera* (Vigors).

A common parasite on Starlings, occurring in several different forms; probably a new genus should be established.

Text-figure 24.



Philopterus acanthus. Male copulatory apparatus. × 150.
BP. basal plate. *LE.* lower endomere. *P.* paramere. *E.* endomere.
Pen. penis. *T.* telomere.

Philopterus acanthus C. (**5**, p. 101). (Text-fig. 24.)

Two ♀ ♀ in company with *Nirmus ochropygus* on *Hæmatopus ostralegus* (Linn.).

I am able to describe the male copulatory apparatus from a preparation kindly lent me by Mr. Waterston. This belongs to much the same type as that in *P. humeralis.*

Male Copulatory Apparatus.—Basal plate: The characteristic feature is its small width in proportion to the dimensions of the parameres and mesosome, which are attached to it. Basal transverse band very convex. *Parameres*: Large powerful rods, with large circular condyles working over the tiny articular surface offered by the posterior lateral angles of the basal plate. Distally they bend in somewhat towards one another. Subapically a minute hair. *Mesosome*: There are two endomeres, a lower and an upper, the former being a small deeply bifid plate, each limb of the fork running out behind into an attenuated tip. The upper endomere has two wings, narrower at the distal end than in *P. humeralis*, and here solely consisting of the lateral tooth or notch pointing outwards. The *penis* is a delicate rod with a large bulbous base (hypomere); above lie the "winged" telomeres, which together look like a javelin's head.

A comparison between text-figures 22, 23 & 24 clearly indicates the homologies between the parts in the three species.

Family Lipeuridæ.

The Lipeuri of Struthious Birds.

Degeeriella asymmetrica N. is found on the Emu (*Dromæus novæ-hollandiæ* (Lath.)), *Lipeurus asymmetricus* P. on two species of Rhea (*Pterocnemia pennata* (D'Orb.) and *Rhea macrorhyncha* Scl.), *Lipeurus quadrimaculatus* P. on *Struthio camelus* Linn. and *Rhea americana*, *Lipeurus latus* P. on *R. americana*. There can be but little doubt that these four species are related to one another and should be grouped together. Subsequent research and the rediscovery of Piaget's *L. latus* will probably result in the establishment of three new genera placed together in a new subfamily.

Harrison (22) has already suggested that *D. asymmetrica*, *L. asymmetricus*, and *L. quadrimaculatus* should be regarded as congeneric. From the new genus established below to include *L. asymmetricus* and *L. quadrimaculatus*, I have omitted *D. asymmetrica*, as in my opinion it should stand in a genus by itself. It is a curious and significant fact that in three of these species parasitising Struthious birds the margin of the anterior part of the head is from some cause by no means evident asymmetrically developed. The asymmetry in the anterior incrassation of the head is least developed in *L. quadrimaculatus*, while in the larva of this species, as well as in the larva of *L. asymmetricus*, the asymmetry is absent even in Stage II. That *D. asymmetrica*, in which the adult asymmetry is most developed, the whole of the preantennal region being bent over on itself to form a longitudinal channel, is a derivative of the other two species seems clear from the observation made by Harrison that the larvæ of *D. asymmetrica* possess asymmetrical heads of "a precisely similar structure" to that found in the adults of the other two.

A great deal more collecting and investigation are necessary before any satisfactory conclusions can be drawn upon the relationship of the Mallophaga parasites to their Struthious hosts.

STRUTHIOLIPEURUS, gen. nov.

Lipeuroid: antennæ sexually dimorphic. Incrassations of anterior margin of head placed asymmetrically. Left mandible with an enormous basal process almost as large as the mandible itself. In the thorax clavicles present as thin splints running inwards and backwards from the antero-lateral angles to join a band which goes vertically downwards to be inserted into the transverse acetabular bar. Abdomen with thinly chitinised transverse tergites. Two transverse rows of fairly long silky hairs on each tergite. Hairs at the sides numerous and fairly long. Male copulatory apparatus characteristic.

Genotype: *Struthiolipeurus asymmetricus* Piaget (**23**, p. 54).

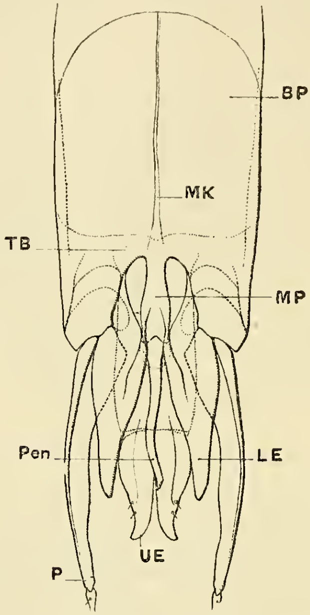
The genus to include *S. quadrimaculatus* P. (**3**, p. 298).

STRUTHIOLIPEURUS ASYMMETRICUS P. (Text-fig. 25.)

I collected several specimens of this species personally on a live Rhea in the Gardens.

Male Copulatory Apparatus.—Basal plate: Dorsally trough-shaped, with a longitudinal median keel. At the posterior end the sides of the trough become steep, and a bridge runs across from side to side in the form of a fairly narrow transverse band, from the middle third of which a parallel-sided plate runs forward between the parameres, ending in a straight truncate margin, to which the upper endomeres are attached. Beneath this transverse band is another running across the floor of the trough from side to side. Like the dorsal one this sends forward a median piece between the parameres, and near the end of it the penis arises. The posterior lateral angles of the basal plate are much produced, deep dorso-ventrally, and square. *Parameres*: long tapering rods, the apex curiously formed (see text-fig. 25, P). *Mesosome*: Each upper endomere is roughly triangular, being broad at the base and narrowing towards the tip, where it is slightly decurved. The piece may best be likened to the rhamphotheca of some bird of prey when macerated off the skull; it is actually double, being bent upon itself, the two leaves gaping wide enough to admit of the introduction of the dissecting-needle. In this way each upper endomere "gapes" outwards. The lower endomeres take origin further back, one on each side of the base of the penis. They are slender and wedge-shaped, rather long. The *penis* is a long, narrow, elongate rod, with a somewhat swollen base, which lies almost buried between the dorsal and the ventral median processes of the basal plate.

Text-figure 25.



Struthiolipeurus asymmetricus. Male copulatory apparatus. × 140.

BP. basal plate. *MK.* median keel. *TB.* transverse band. *MP.* median piece. *Pen.* penis. *LE.* lower endomere. *P.* paramere. *UE.* upper endomere.

The Rest of the Lipeuri.

Lipeurus subsignatus Giebel (**5**, p. 232).

Several specimens, including a male, from *Phœnicopterus roseus* Pall.

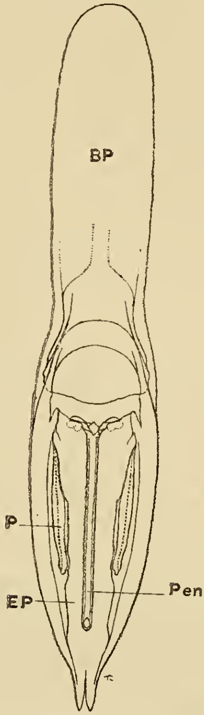
Lipeurus jejunus Nitzsch (**5**, p. 240). (Text-fig. 26.)

Males, females, and larvæ from *Branta leucopsis* (Bechst.).

Male Reproductive System.—This was carefully figured and described by Kramer as long ago as 1869 in the 'Zeitschrift für wissenschaftliche Zoologie' (**12**). Testes and vas deferens as usual. The *vesicula seminalis* is an elongate double-chambered sac, the median partition indicated externally by a longitudinal groove.

Male Copulatory Apparatus.—*Basal plate*: Rather long, narrow, of uniform thinness, the lateral margins indistinct, and the colour dull greyish. *Mesosome*: Attached to the posterior margin of the basal plate is a large, broad, trowel-shaped plate—the mesosome. When the apparatus is withdrawn, as shown in the figure, the parameres, slender rods shorter than the mesosome, lie dorsally

Text-figure 26.



Lipeurus jejunus. Male copulatory apparatus. × 130.
BP. basal plate. *P.* paramere. *EP.* endomeral plate. *Pen.* penis.

and inside the lateral margins of the mesosomal plate. When the apparatus is in action, however, the base of the mesosome swells up and broadens out, carrying the parameres with it, so that the latter come to lie laterally in their normal position. The *penis* is a perfectly straight elongate tube, with an aperture at its tip and with a forked base.

Lipeurus heterogrammicus N. (5, p. 220).

Plenty of material of this minute species was sent, collected on *Caccabis chukar* Gray.

Lipeurus antilogus N. (**5**, p. 223).

Males, females, and larvæ in numbers from *Eupodotis edwardsi* (Gray & Hardw.).

The specimens were identified from Piaget's description and figure (**3**, p. 374, pl. xxx. fig. 3), with which, however, they did not entirely agree. After examination of authentic *L. antilogus* the Society's specimens may emerge as a new form.

Lipeurus variabilis N. (**5**, p. 219).

Several specimens of both sexes from *Phasianus scintillans* Gould.

This is a difficult species, of which several varieties have been described. All the material badly needs overhauling and dissection in conjunction with allied species.

Lipeurus burnetti Packard (**24**). (Text-fig. 27.)

Two ♂ ♂ and 4 ♀ ♀ from *Polyplectron chinguis* (Müll.).

The description which follows is incomplete, as the material was insufficient to settle the question of the preputial sac, which is therefore omitted.

Male Copulatory Apparatus.—Basal plate: Unusually broad, with very narrow, lateral, marginal bands. Anterior margin very convex. *Parameres*: Quite short and inwardly curved. *Endomeral plate*: This is much longer than the parameres and at the base almost as broad as the basal plate. Behind, it sends forward a narrower parallel-sided portion shaped something like a duck's bill (see text-fig. 27). Note the peculiar sculpturing of the inner surface of the paramere.

Lipeurus secretarius G. (**5**, p. 213).

Many specimens from *Serpentarius serpentarius* (Miller).

This species belongs to a well-defined group of large handsome Lipeurids infesting birds of prey and characterised by the four or six curious, more or less circular incrassations on the front margin of the head. They undoubtedly form the material for a new generic grouping.

Lipeurus forficulatus N. (**5**, p. 238).

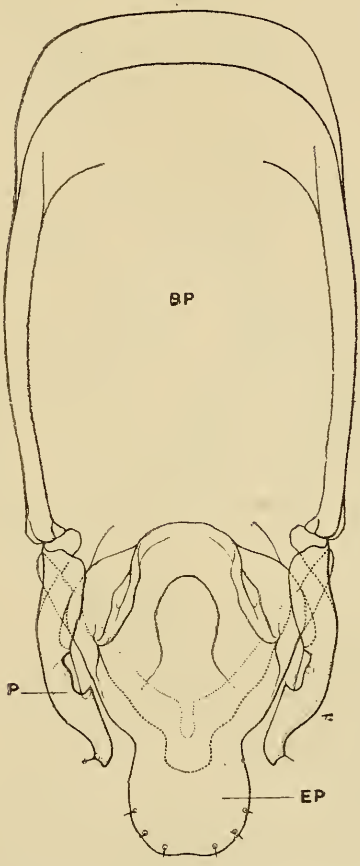
A goodly number of specimens of both sexes and larvæ from the Red-backed Pelican (*Pelecanus rufescens* Gmel.).

This species, readily distinguished from *L. bifasciatus* P. by the shape of the antennæ in the male, is found on *P. onocrotalus* Gmel. The present specimens were paler in colour than is usual in this species.

Larvæ.—Two stages, probably I. and II., have been figured by Kellogg without any comment (**25**). The chætotaxy of the abdomen in Stage I. (?) shows the common and perhaps primitive arrangement of two hairs on each dorsum in the middle field. In

Stage II. (?), the only stage included in this collection, there are two hairs on the dorsum of each segment, two on each pleura (very short on segments I. and II.), and on segments VI. and VII. a long hair behind each spiracle. On the sterna there are four hairs in each segment excepting on the last two segments, where there are only two. As compared with Stage I. (?) there

Text-figure 27.

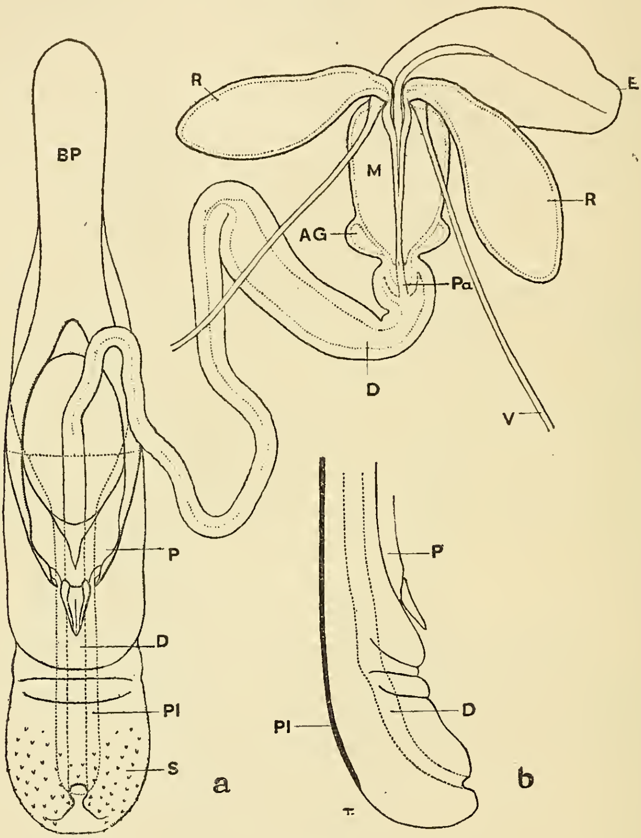


Lipeurus burnetti. Male copulatory apparatus. × 180.
BP. basal plate. *P.* paramere. *EP.* endomeral plate.
Note the sculpturing of the paramere.

is a slight difference in the grouping of the hairs on each side of the hind margin of the metanotum.

Male Reproductive System (text-fig. 28).—The *testes* and *vasa deferentia* require no special mention. The rest of the parts are complex in structure, consisting of an oval end-sac—the true *vesicula seminalis*—which leads by a narrow neck into a second well-defined portion, for convenience of description called the middle-sac. Further, elongate reservoirs, elegantly flask-shaped,

Text-figure 28.



Lipeurus forficulatus. Male reproductive system and copulatory apparatus. × 105.

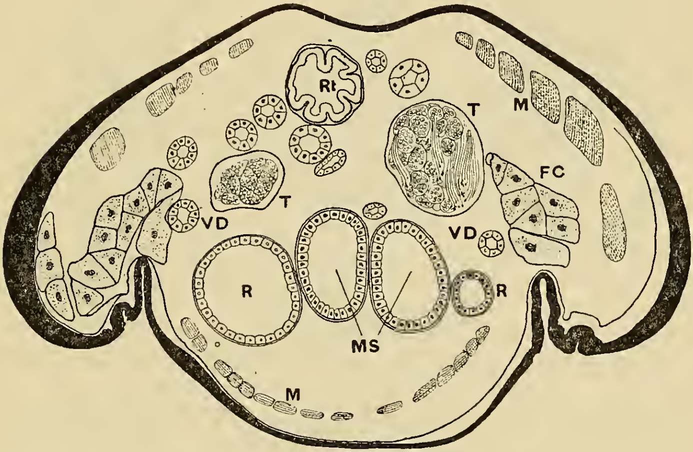
a. seen from above; *b*. seen from the side. Testes not shown.

BP. basal plate. *P*. fused parameres. *D*. ductus. *Pl*. strip of narrow chitin along ventral surface. *S*. extrusible sac. *R*. reservoir. *E*. end-sac of vesicula seminalis. *M*. middle-sac. *AG*. accessory gland. *Pa*. cone-shaped papilla. *V*. vas deferens.

When *in situ* the vesicula and associated parts lie much further forward in the body-cavity in front of the basal plate, and the sac when extended in copulation curls over the back of the abdomen.

lie, one on each side of the middle-sac, and enter by a narrow neck into the narrow section between the end-sac and middle-sac. The text-figure shows the connections at this point with the *vas deferens*. The *ductus ejaculatorius* for a considerable portion of its course on leaving the middle-sac is large and glandular and almost as broad as the middle-sac itself. The narrow canal between the latter and the ductus projects into the lumen of the ductus as a minute cone-shaped protuberance. The broad upper part of the ductus, after two bends, giving the tube an S-shaped form, narrows into a small canal of several coils, which enters lower down into the upper part of the retracted preputial sac.

Text-figure 29.



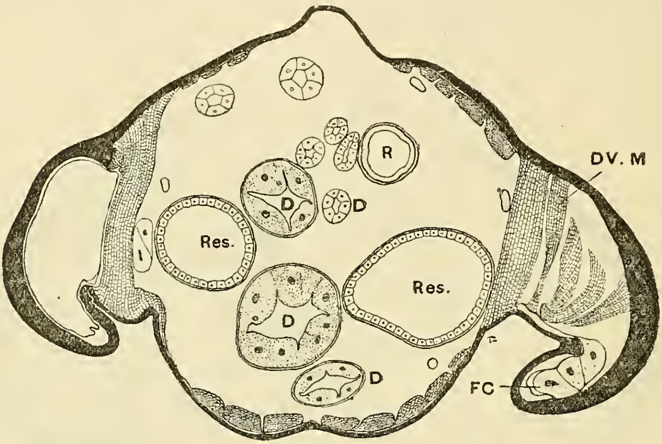
Lipeurus forficulatus, ♂. Transverse section through the abdomen at the level of the middle-sac of the vesicula. (Diagrammatic.)

Rt. rectum. *T.* testis. *M.* muscles. *FC.* fat cells. *VD.* vas deferens. *R.* reservoir. *MS.* middle-sac.

Sections of these parts reveal some important points (see text-figs. 29 & 30). Externally the end-sac is marked by a median longitudinal groove. In cross-section the mid-sac, as in the *vesicula seminalis* of other insects, is seen to be double, consisting of two distinct tubes closely applied one to the other. Similarly, the middle-sac is also double. Whereas the end-sac contains sperm, the two "reservoirs," the middle-sac, and the two minute vesicles, one on each side at the lower end of the latter, contain a coagulable white secretion, which possibly plays the part of spermatophragmen, serving for the maintenance of the spermatozoa during copulation.

The walls of the end-sac are fairly thin. Those of the middle-sac are thicker, the cells being of varying lengths and their ends projecting irregularly into the lumen. The walls of the flask-shaped reservoir are very thin, consisting of a clear hyaline external membrane and an inner epithelium of short cells. The walls of the upper portion of the *ductus ejaculatorius* are very thick, consisting of extremely high cells, the shape of which is not clear in the preparations on account of unsatisfactory fixation. For the same reason the histology of other parts remains obscure.

Text-figure 30.



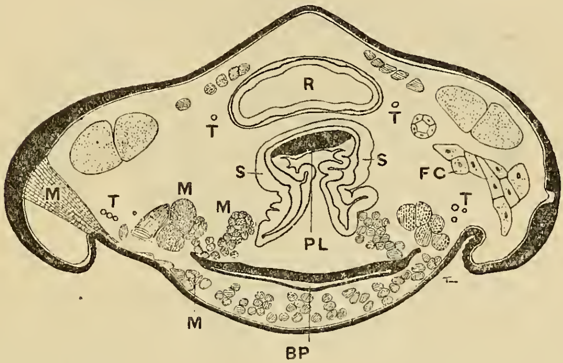
Lipeurus forficulatus, ♂. Transverse section through the abdomen, behind the middle-sac of the vesicula. (Diagrammatic.)

R. rectum. *D.* ductus. *Res.* reservoir (lower end). *DV.M.* dorso-ventral muscles. *FC.* fat-cells.

Male Copulatory Apparatus (text-fig. 28).—The copulatory apparatus belongs to the simple type, consisting of basal plate and parameres and an extrusible membranous sac (see Part I., p. 257). Fortunately in the collection were two males with the sac extruded, and, as usual, when in this condition turned upwards and backwards over the terminal segments of the abdomen. A detailed account is therefore included of the sac when extruded and when retracted, with some remarks upon the mechanism of extrusion and retraction.

The *basal plate* is rather long and narrow, of a dull grey colour, the lateral margins a little concave. The *parameres* at their distal ends are fused with one another. The text-figure shows that the fused parameres are dorsal to the sac which shoots outwards and upwards from under the chitinous arch formed by the parameres. The sac proximally possesses two characteristic transverse rolls caused by two deep furrows. Distally it is studded with a number of minute denticles and its opening is subterminal on the dorsal surface. From between the parameres and continuous at that point with the basal plate is a small endomeral plate continued backwards as a long, narrow, thick, parallel-sided, chitinous strip which supports the sac on its lower side along the middle line. The ductus can be seen through the wall of the sac running backwards into the abdomen, where it lies on the dorsal side of the basal plate.

Text-figure 31.



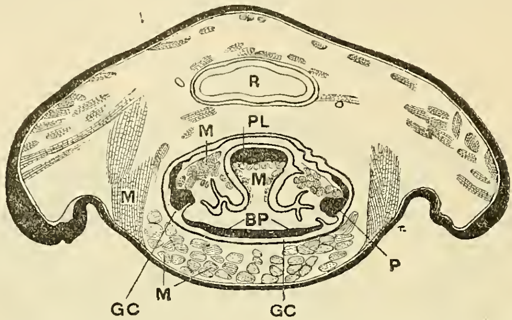
Lipeurus forficulatus, ♂. Transverse section through the abdomen showing the copulatory sac lying retracted within the body-cavity above the basal plate. (Diagrammatic.)

R. rectum. *T.* trachea. *S.* sac. *PL.* narrow chitinous strip on ventral surface of sac. *M.* muscles. *FC.* fat-cells. *BP.* basal plate, showing the rift.

The Apparatus when retracted.—During retraction the sac is continuously invaginated until the distal end with its denticles comes to lie farthest forward within the abdominal cavity a little anterior to the fore end of the basal plate. The thick endomeral strip on its lower wall, of course, curls upwards and travels in with the rest, so as to form in the retracted state an enigmatic loop difficult to interpret until an extruded sac is examined. In cross-section, therefore, the endomeral strip forms the lower wall of the *inner* tube (see text-fig. 32). A similar endomeral loop with a similar history was described in Part I., p. 271, for *Trichodectes latus*. The diagram should make the relation of the parts quite clear.

It should be clearly understood that the parameres are at no place rods or appendages discrete from the sac. At their distal end (text-fig. 33) a membrane crosses between them dorsally and another membrane crosses ventrally. If the parameres became shorter these two membranes would become continuous with one another and with the dorsal wall of the outer tube, and if, finally, they disappeared we should have a simple exsertile tube. Sections anywhere across the length of the parameres all show them to be local chitinisations one on each side of a membranous tube—the outer tube. In text-fig. 32 a section is shown of this outer tube contained within the genital chamber, and the basal plate and parameres are seen merely as local thickening in the continuous wall of the sac.

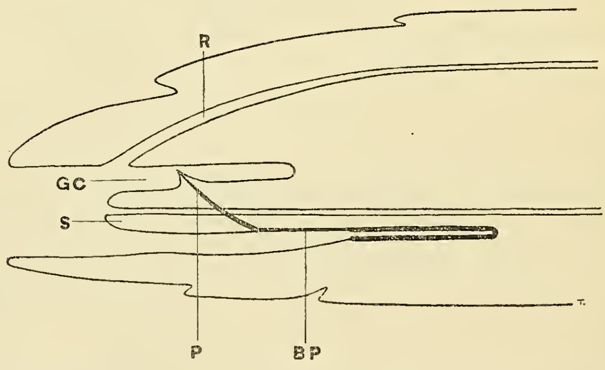
Text-figure 32.



Lipeurus forficulatus, ♂. Transverse section through the genital chamber, with the copulatory apparatus retracted. (Diagrammatic.)

R. rectum. *M.* muscles. *PL.* chitinous strip on ventral surface of the sac. *BP.* basal plate between the base of the parameres (*P.*). *GC.* genital chamber.

Text-figure 33.



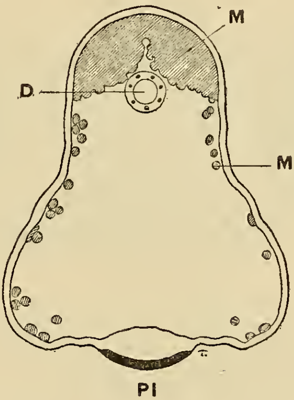
Lipeurus forficulatus, ♂. Longitudinal section through the end of the abdomen. (Diagram.)

R. rectum. *GC.* genital cavity. *S.* sac. *P.* paramere. *BP.* basal plate.

Now, if reference be again made to the diagram (text-fig. 33) it is evident that the dorsal sector of the genital chamber ends much sooner than the ventral. Reading the sections forwards establishes beyond doubt the interesting character of the basal plate. The sole remaining ventral part of the genital chamber becomes smaller and smaller until it is no more than a narrow cleft below the basal plate. Next, its lower wall becomes chitinous and is approximated to the basal plate, which is for the rest of its course a circle of chitin squashed perfectly flat into a plate with only a narrow rift between (text-fig. 31).

The interest in this observation centres in the fact that it explains the nature of the basal plate. At the base (near the parameres) this begins as an ordinary squamiform apodeme on the lower wall of the sac within the genital chamber. It runs back (*i. e.* in the direction of the head) as an ordinary tubular apodeme formed as an invagination of the ectoderm in the lower part of the genital chamber. This "tube" is compressed into a flat plate and its lumen reduced to a thin rift—continuous with the genital chamber.

Text-figure 34.



Lipeurus forficulatus, ♂. Cross-section through the extruded sac just behind the opening.

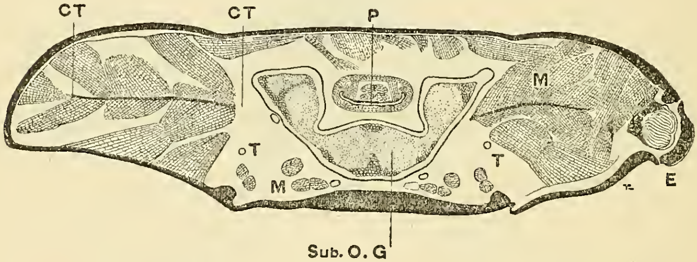
D. ductus. *M.* muscle mass. *Pl.* narrow chitinous strip on ventral surface.

Extrusion and Retraction.—On the ventral surface of the basal plate there is a series of longitudinal muscles which arise in front from the anterior portion of the basal plate and are inserted behind into the terminal sternite of the abdomen, serving to thrust the plate forward and expose the parameres through the terminal abdominal opening. Text-fig. 28 *a* shows that the parameres along their dorsal margin curve in somewhat. Underneath this overhanging ledge small muscle-fibres run back along the length of the parameres and are attached to the base of the basal plate, doubtless serving to draw the tip of the fused parameres upwards in a dorsal direction, which is its usual position when in copulation. On each side of the basal plate is a large-bellied muscle arising from an abdominal sternite some way forward and inserted by a delicate tendon into the lower end of the basal plate. These are retractor muscles, withdrawing the apparatus within the body after copulation. The continuous invagination of the sac is brought about by the contraction of a great many small muscles arising from the dorsal surface of the basal plate and inserted successively along the walls of the sac. They are particularly numerous above the ductus at the distal end of the sac, being inserted just behind the opening (text-fig. 34).

Extrusion of the sac is probably caused by blood-pressure upon contraction of the powerful dorso-ventral abdominal muscles segmentally arranged.

The above is not offered as a complete account of the mechanism of this complicated apparatus. The manifest lacunæ in the description must be filled in only after a great deal more study of the parts.

Text-figure 35.



Lipeurus forficulatus, ♂. Transverse section through the head behind the antennæ. (Diagrammatic.)

CT. chitinous tendon for attachment of mandibular muscles (*M*.). *P*. pharynx. *T*. trachea. *Sub.O.G*. subœsophageal ganglion. *E*. eye.

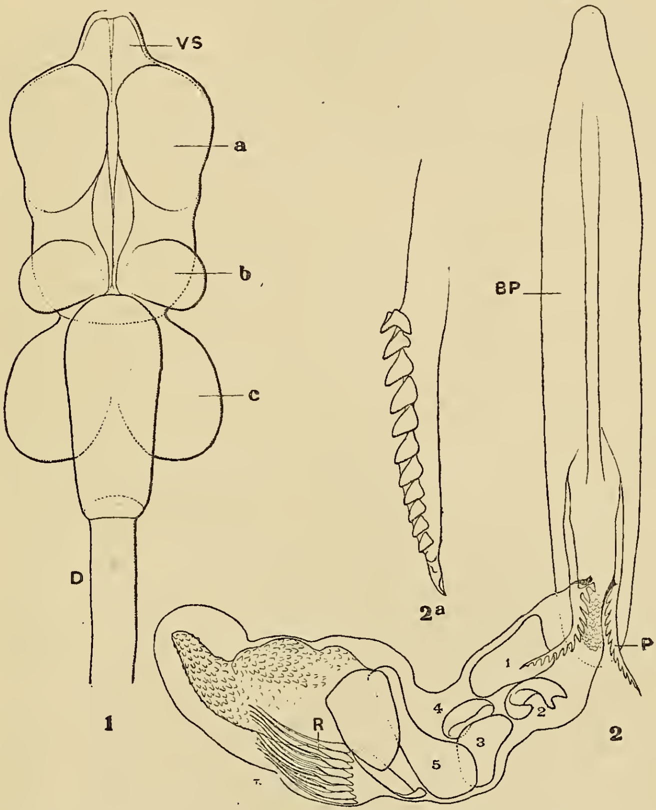
Mouth-parts.—Labium: The labial sclerite is present merely as a narrow transverse band near the anterior margin. *Isopogometric Apparatus*: Lyriform organ without posterior cornua. Anterior cornua are broad and flat, convex on the outer margin, and in length equal to that of the "nucleus" itself; from each side a chitinous bar runs up the wall of the pharynx, which is further supported dorsally by a short median longitudinal splint. Behind the lyriform organ the chitinous intima of the pharynx bears a number of minute teeth. As in *Lipeurus ferox* (9, text-fig. 24) there is a compound hypopharynx consisting of a narrow, short, median piece, and on each side a longer rectangular strip. The pharynx (see text-fig. 35) is supplied with numerous small muscles—circular, longitudinal, and transverse. The latter are developed further forward, and consequently do not appear in the text-figure. There are two pairs, one running from the ventral and the other from the dorsal side of the skull.

Genus Pectinopygus Mjöberg.

Pectinopygus pullatus Nitzsch (**5**, p. 236).

From time to time a considerable amount of material of this species from *Sula bassana* (Linn.) and from the Cape Gannet (*Sula capensis* (Licht.)) was sent in.

Text-figure 36.



Pectinopygus pullatus, ♂. 1. reproductive system. 2. copulatory apparatus. ×90. 2 *a*. paramere enlarged. × 270. Testes and vasa deferentia not shown.

VS. vesicula seminalis. *a*. *b*. *c*. lobes. *D*. ductus. *BP*. basal plate. *P*. paramere. *R*. retinaculum. 1–5. sclerites on the sac.

Male Reproductive System (text-fig. 36).—The *vesicula seminalis* is complex. It consists of a large, swollen, two-chambered sac of somewhat irregular contour and outline. At the anterior end are two small, closely united offshoots from the central chambers, and at the posterior end, where the *vesicula* joins the *ductus*, are two pairs of accessory lobes each attached to the vesicula by scarcely any appreciable neck or constriction. The first pair of lobes are quite small and lie postero-ventrally. The second pair run backwards side by side above the issuing ductus, and are nearly half as long as the vesicula and together almost as broad. The *ductus ejaculatorius* is broad at its upper end and rather short. About midway towards the copulatory apparatus there is a small bend where a pair of small glands are attached.

Male Copulatory Apparatus.—Throughout the Mallophaga, as indeed in Insects generally, the structure of the male apparatus for copulation displays a remarkable variety. In the Mallophaga the strangest condition is found in *Pectinopygus pullatus* (see text-fig. 36). Mjöberg (**6**, p. 246, fig. 139), who established the genus, in purporting to describe and figure the apparatus describes only the basal plate, parameres, and ductus. The whole long extrusible sac, with its complex chitinisations, is omitted—swept away in dissection possibly in mistake for the rectum or rectal fæcal matter. *A propos* of the sac, Mjöberg states that, although present, it is "jedoch nicht gut entwickelt." And of the *ductus ejaculatorius*: "Er zeigt in der Innerwand ein in einer Spirale verlaufendes Chitinband." But the *ductus* contains no such spiral band, and as it is difficult to suppose Mjöberg mistook the extrusible "preputial sac" for the ductus, there may be here a question of a distinct but unrecognised species.

Basal plate.—This is long and narrow, with a longitudinal median keel upon its lower surface. The two peculiar processes (P), which probably represent parameres, do not articulate with the basal plate, but are attached to its dorsal surface along the length of the whole "stalk" or unpectinated portion. The distal end is band-like and curves outwards. On the inner surface of each are about thirteen denticles like sessile buds on a stalk, graduated in size from the base to the tip. Below and quite continuous with the basal plate lies an endomeral plate, formed of a rather clear chitin, the upper surface presenting a tesselated appearance. In regard to the "preputial sac," the text-figure lays no claim to a representation of this in the natural position. Unfortunately no male specimen was obtained with the sac extruded. Consequently the remarkable sclerites 1, 2, 3, 4 and 5 are shown lying in no very intelligible position. However, the shape of the pieces is seen together with the structure of the large "retinacular comb" at the distal end, recalling a similar structure figured for *Anatœcus*. The "comb" in *Pectinopygus* consists of a row of about nine elongate bands. Each band at the base has square angles, is fairly broad and parallel-sided for a short distance up before it divides into two, forming a fork with two elongate prongs. All the nine forks are really one continuous piece, the divisions between being filled by a sort of amalgam of thin transparent chitin.

The whole of these pieces, as well as the basal plate and parameres, which in their ensemble Berlese conveniently collects under the name *Perifallo* (26), are, it must be remembered, simply chitinous plaques developed upon the outside tube of the apparatus. In *Pectinopygus* these are remarkable from their miscellaneous character, whereas in other Mallophaga the mesosomal parts are usually capable of ready classification into the endomeres and telomeres and penis.

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